THE STORY OF INVENTION

MAN, THE MIRACLE MAKER

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THE STORY OF INVENTION

MAN, THE MIRACLE MAKER

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HENDRIK VAN LOON

MULTIPLEX MAN

THE STORY OF INVENTION

Man, the Miracle Maker

By HENDRIK VAN LOON

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To

LOUIS AGASSIZ FUERTES

WHO NEVER DIED

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PROGRESS

Foreword

In the beginning everything was very simple. The earth was the center of the universe. Heaven was a large dome of beautiful blue glass.

At night the little angels pricked holes through that dome and behold! there were the stars.

But one day a courageous man, armed with a threepenny telescope, climbed to the top of a tower and took a long and serious look.

From that moment on there was trouble.

First of all, the sun had to be requested to move to the center of the universe. Next it was discovered that our far-famed solar system was not a "universe" at all but a mere insignificant detail of a mysterious and vast project which in turn was an even more insignificant detail of an even more mysterious and vaster plan which was vaguely supposed to be an absolutely insignificant detail of an out-of-the-way corner of the Milky Way.

These revelations caused great perturbations not only among the theologians but also among the mathematicians and astronomers. Thus far they had been able to measure the distance between the earth and the moon and even that between the earth and the nearest planets with the help of kilometers and miles.

But now, when the famous old human "cosmos" had quite unexpectedly grown into something more important than a convenient stage-setting for a chapter in one of the holy books of the East; when it was gradually becoming evident that there existed stars of such incredible size that the greater part of our own solar system could be hidden inside their bellies without inconveniencing the patients in the least; when the zeros which had

sufficed for the simple calculations of our great-grandfathers were multiplying themselves trillion- and quadrillion-fold; it was felt that the time had come to devise a new geometrical standard which should keep the astronomers from wearing out their elbows while handling their slide-rules.

For this purpose the so-called "astronomical unit" of 92,900,000 miles was established. It represented the mean radius of the earth's orbit, and it was a handy enough yard-stick, as long as one did not venture too far away from home.

But once among the real stars (the big ones, not the little fellows which are our own neighbors) such "astronomical units" became mere trifles, and it was necessary to think of something a little more substantial than a paltry 92,900,000 miles.

Just then Albert Michelson was experimenting with light and had figured out that a ray of light (of course it is sheer nonsense to speak of "rays of light," but I am using the word because we are still so hopelessly involved in the poetic nomenclature of the Romantic Period that centuries will have to elapse before we shall be able to think in the terminology of the Age of Science)—as I was saying, just then Michelson had discovered that light is a substance which moves at the rate of speed of 299,820 km. per second, and this gave some one a bright idea. By multiplying 60 seconds with 60 minutes, the result with 24 hours and this result with 365 days, he came to the agreeable conclusion that light traveled something like 10,418,623,400,000 km. per year. This distance was then called a "light year" and became the tape-measure of the modern heavens.

At first it seemed that now everybody would be happy. Before the introduction of the "light year" Centaur, our nearest neighbor among the stars was 25,000,000,000,000 miles away from us. Afterwards it was possible to say offhand: "Centaur? Oh, yes, a mere 4.35 light years away from us. Almost too close for comfort!"

But alas, the appetite of the astronomers for distances was insatiable. They discovered nice little orbs situated at a distance of twenty or thirty thousand "light years." Then they made a bold dash for the nebulæ, those luminous spots which remind us of microbes seen underneath a microscope, and they figured out that some of them were situated at distances which varied between two and three million light years.

Then, even the "light year" became just a trifle ridiculous. But who would give us something better?

. . . . . .

Now all this is not spread before your admiring eyes for the mere purpose of showing you that I am either a man of profound erudition or a person lucky enough to have acquired an Encyclopædia Britannica on the installment plan. I am playing these few chords on the instrument of eternity to sound a note of warning in regard to the rest of this book.

When the earth was rudely deprived of her favored position as the "center of the universe" there were those who thought that man, too, was about to be pushed from that high pedestal upon which, by right of eminent arrogance, he had placed himself as soon as he had ceased to walk on all fours. Surely within a universe composed of tens of thousands of nebular spots, each of them bigger than a couple of millions of square light years, man would feel himself reduced to such infinitesimal proportions of insignificance that he would cease to boast about his divine origin and would begin to see himself as what he is—a fairly clever animal and nothing else.

But soon it became evident that such a change in his mental attitude was impossible, that a fire in his own back yard would always be of much greater importance to him than a disastrous volcanic eruption on reddish Antares (which has a diameter of 640,000,000 km.), and that a suspicious knock emanating from the cylinder of his own car meant vastly more to him than

the rumor that Betelgeuse (the only fixed star that ever succeeded in breaking into the Sunday supplements, through sheer weight and bulk) was threatened with extinction. Not to forget that dreadful throb in his wisdom tooth which would fill him with a much more profound apprehension for the immediate future of the human race than the information that the faithful old moon was about to join her five former sisters in oblivion.

And perhaps that was just as well.

For while the astronomers were extending and enlarging the universe until it threatened to become grotesquely infinite, other scientists were tackling the atom and by reducing that hapless mite to smaller and ever smaller proportions, they finally discovered a world of infinitesimally small particles which on a scale of $\frac{1}{100,000,000,000,000}$ of a millimeter disported themselves with the regularity and precision of so many full-fledged, ultra-microscopic solar systems and performed such marvels of abbreviated balancing and counterbalancing that the average brain, in ever increasing whirls of dizziness, was forced to refuse to believe such things possible or go stark mad.

No, it was just as well that man should remain the center of the universe. At least, until that day when he shall have acquired a real brain.

. . . . . .

Nevertheless revelations of this sort were bound to have some influence, however slight, upon the attitude of the human race towards the problems of life, and the hero whom you will meet within the pages of this book will prove very different from the patriarch of ancient days, who considered that he had been appointed chief beneficiary of all creation and as such could slay and murder and maim all his neighbors of the animal kingdom and that the universe had no other purpose than to cater to his wants and supply his manifold needs.

He may be the beginning and the end of all things (as he

has been told for thousands of years) but in his heart of hearts he is beginning to doubt it, and he is gradually commencing to suspect that there is no beginning and no end, that the "here and now" of a million years ago was pretty much the same as the "here and now" of to-day or the "here and now" of a billion years hence.

He may be the highest summit of perfection among all living matter, but he prefers to suspend judgment until he shall have discovered what sort of life has developed on some of the other billions of stars which keep him company on his voyage through space.

In short, after a detour of several thousand years, he dares once more to be conscious of that noble classical ideal which summed up the philosophy of the desirable life in the magnificent words:

"We are all of us merely human beings and nothing pertaining to the universe we think foreign to us or unworthy of our attention."

Basing his right of inquiry upon the patent royal of an almost sublime curiosity (that was bestowed upon him on the day of his birth), the hero of this book intends to pry into every corner, to explore every region, to investigate the hidden meaning of every phenomenon which comes within the reach of human reason and to do this without respect for anybody or anything beyond the limits laid down by that demonstrable truth which shall be the corner-stone of our future development.

If he prove to be successful in his search, he shall let his neighbors know without pride. If (for the moment) he find himself baffled by the difficulties that confront him, he shall confess his defeat without shame and shall leave it to others, better equipped than himself, to try again.

Above all things, he shall say "yes" to Life and, armed with patience and forbearance and good-natured humor, he shall

relentlessly push forward into the realm of the unknown until the little drop of energy which he has borrowed for a short space of time shall be needed for some other purpose, when he expects to surrender the loan without a single word of regret, as he has learned that both life and death are but expressions of one and the same idea and that nothing really counts in this world except the courage with which the individual dares to attack the one problem to which there is no definite solution, the problem of existence.

. . . . . .

All this, I know, sounds rather complicated.

But it is not half as complicated as you think, if you will only read it rather slowly and try it again a couple of times.

Those who find that job too much for them had better drop the book right here. They would soon be bored and annoyed and they would wonder what it was all about and why it was ever written and they could employ their time much more profitably by going to the movies.

But as for the others, those who have already guessed what I am driving at, they too are not in need of any further introduction. They will understand that while I may not have solved any problems definitely, I have tried very, very hard to show them how certain things happened to happen the way they actually happened because that was the only way they could possibly happen, and along which lines we may hope for the ultimate emancipation of mankind from that cruel tyranny which for so many hundreds of thousands of years has turned this earth into a shambles and which was the direct and inevitable outcome of man's cowardice when face to face with his prejudices and his ignorance.

. . . . . .

And now one final word.

The great work of delivery will never be accomplished with-

out steadfast and unselfish service on the part of a small band of chosen pioneers.

Some of my readers may even suspect that I want them to be among the leaders whose praises are sung within the pages of this volume.

Their suspicions would be correct.

For that, on the whole, is why I wrote the present book.

H.v.L.

Veere. August 31, 1928.

THE STORY OF INVENTION

Man, the Miracle Maker

SPACE

CHAPTER I

Man the Inventor

One fine day a small speck of dust (it weighed only 6,000,000,000

should be very much out of place in a country which had started to learn the rudiments of civilization one or two million years before ourselves.

And that reminds me of something that has puzzled me for a long time.

Why are people so tremendously interested in detective stories?

"It is the mystery that attracts them," is the usual answer, or "It is the fascination of watching a single vague clew develop into an iron chain of incontrovertible evidence."

For all I know, that may be the true reason. But in that case I wonder why more of them don't take up the study of geology, for the story of our planet is one endless series of the most magnificent riddles and only a few of them have thus far been solved. The others obstinately refuse to divulge their secrets, but in all fairness to them it should be said that there is not a single one among all these various puzzles to which there is not a key.

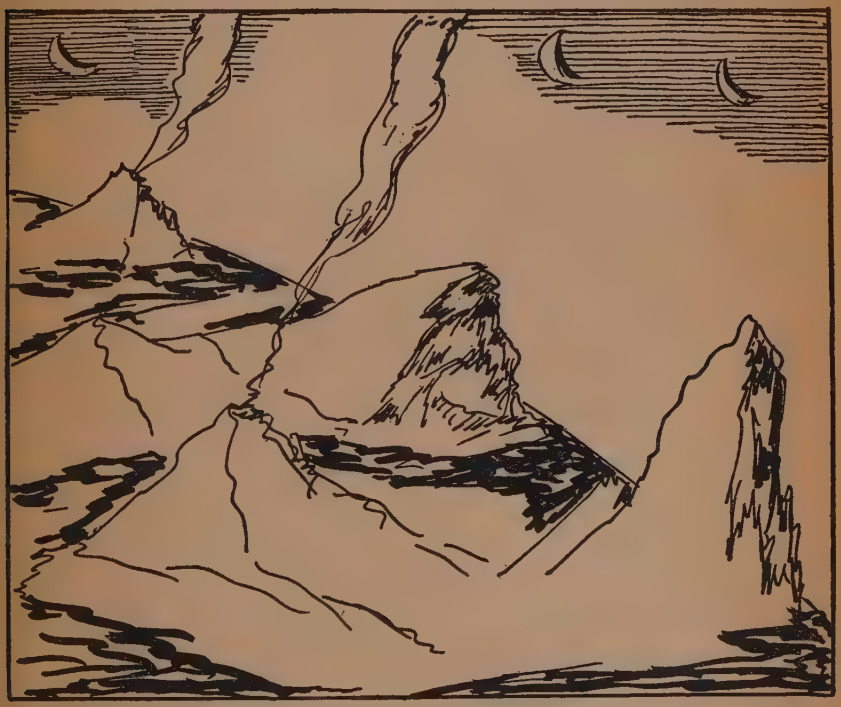
The people of ancient times knew this and they forced the rocks and the plains which were their home to tell them a great many things about their origin and their early past, which were of tremendous importance. But their successors, the humble folk of the Middle Ages, although they were great heroes on the field of battle, were terrible cowards within the Realm of Reason. They asked no questions, but meekly accepted what they were told out of an old book, and curiosity about the planet on which they lived was regarded as nothing less than sacrilege.

To-day the Middle Ages have been relegated to the museum of historical curiosities. Another ten or twenty thousand years and the little crust on which we crawl around with such energy will hold no more mysteries than an aspirin tablet or a pumpkin-pie.

It may seem that I am a little too generous with my thousands

Our Floating Prison

and hundreds of thousands of years, and juggle a bit too freely with the centuries. But that can hardly be helped in these days when fresh prehistoric discoveries have almost quadrupled the period during which we can speak of "history" in the accepted sense of the word as a "continuous methodical record of past events." Besides, such a feeling of the vast duration of the ex-



THE CRUST OF THE EARTH HARDENS

istence of all the things with which we are familiar is very good for the soul and teaches us humility and patience. When we begin to realize that it took our ancestors something like 500,000 years to learn to walk on their hind legs, we feel a little more tolerant towards our own contemporaries when they fail to solve some important problem in less time than we think they ought to take and we get a better slant upon ourselves. We cease to

THE WORLD OF THE FISHES

be so terribly important. We become mere upstarts—creatures which did not make their appearance upon the surface of the planet until millions and millions of years after the majority of the other arrivals—rulers of the universe who only day before yesterday were admitted through the front gate.

. . . . . .

As for the different steps which nature took to arrive at this fine conclusion-on-two-feet, we are still ignorant about many of the details, but in a general way we have at least a suspicion of how it came about.

It all began as soon as the outer crust of our planet had sufficiently cooled to support some sort of life. It was rapidly populated by an endless variety of plants and by multitudes of

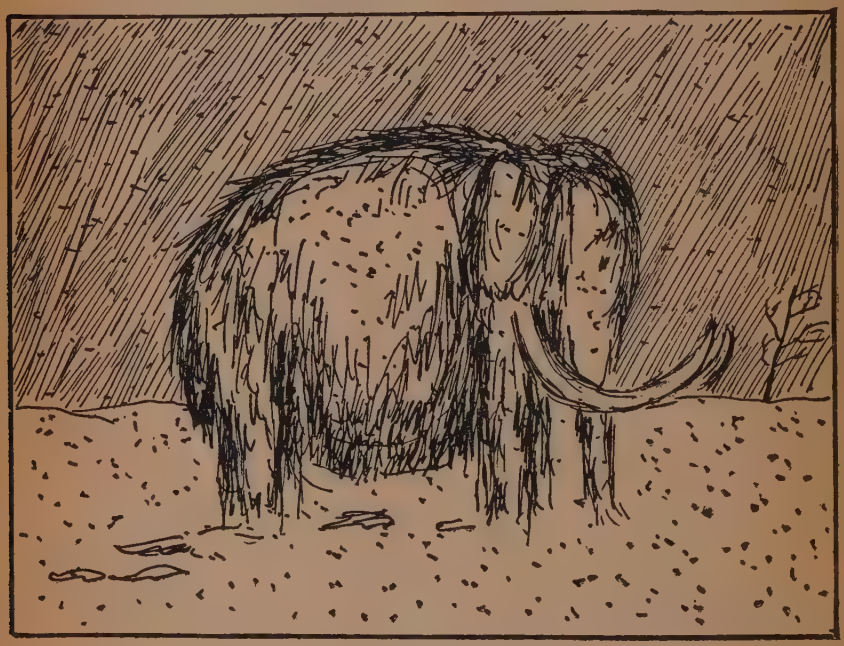
armor-clad, sightless creatures which spent their entire existence in the water and were the undisputed masters of the earth.

We know that some of them remained faithful to the sea and became the ancestors of the fishes upon which we feed to-day; that others developed wings and took to the air and became the grandparents of our modern birds. We have discovered that others, which belonged to the same family as the lizards and serpents of our own day, came to such great estate that for a long while it looked as if our planet was to be permanently dominated by reptiles. For the climate of that period (and please try to think in terms of millions of years and forget all about the dates in your history book, which represents only a couple of seconds in the calendar of eternity)—the moist, damp climate of that period greatly favored the development of

THE WORLD OF THE REPTILES

gigantic monsters, which were as much at home in the water as they were on land and looked and behaved like animated dreadnoughts.

We also know that the period during which the air, the water and the land were the exclusive domain of beasts that measured forty or fifty or sixty feet and that had stomachs as large as the



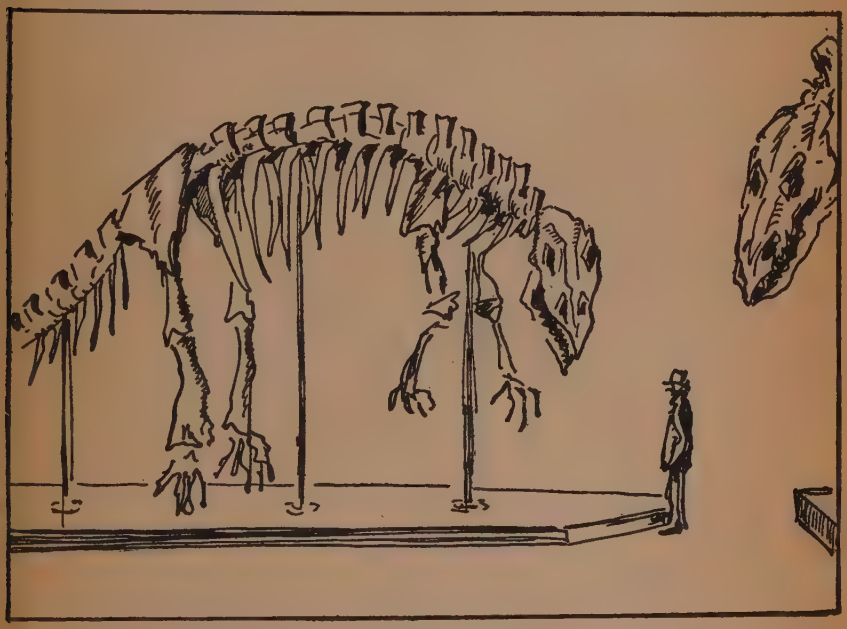
THE DYING MAMMOTH

cabin of a fair-sized yacht, was suddenly followed by an era during which not a single one of them was to be found in any part of the globe.

How and in what way those early rulers of the world came to their ignominious death and why to-day they survive only in pocket-size editions—that is something of which, until a few years ago, we understood nothing at all. Now at last we are beginning to realize that there was not one single cause, but that there were a large number of complicated and interacting reasons and that

the Law of the Inevitable Top-Heaviness of Things, which rules all living matter, had a great deal to do with it.

You know what is happening to-day in the realm of arms. All the good intentions in the world and all the Leagues of Nations in the world are not half as important in making the world safe for reasonably inclined citizens as the plain, prosaic



A Museum Piece Which Ruled the World

fact that the machinery of modern war has grown so cumbersome, has become so incredibly top-heavy, that soon through sheer bulk it will no longer be able to float nor fly nor ride nor go on foot, but will be obliged to wobble and waddle and groan and grunt like a truck in the mire.

The creatures whose ridiculous skeletons grin at us to-day from the show-cases of those museums which are possessed of sufficient floor-space for such an exhibition went through a similar development.

They increased their size and strengthened their armaments until they could neither walk nor swim and were doomed to wade through the mud and slime of those endless marshlands which during that period of the earth's history covered so great a part of the world and which offered no more substantial fare than reeds and seaweeds.

Then when a change in the climate occurred (and sudden and violent changes in climate were more apt to occur then than they are now, owing to a more equitable division of oceans and continents at the present moment), these slow-witted monsters could turn neither to the sea nor to the land in search of a new means of support. And so they were doomed to perish in such a thoroughgoing and efficient manner that of all the countless billions of saurians, which for so many millions of years were the undisputed masters of our planet, not a single one lived to see the coming of the great mammals and the final appearance of man.

That is the story as it is usually told, but I wonder whether it is the whole of the story—whether there is not another angle from which we have never looked at it and which is quite as important as any of the usual excuses for their untimely demise.

Climatic changes no doubt exercise a very important influence upon the comfort and happiness of all living creatures, from microbes to mules.

But climatic changes, unless they are so terrific that they amount to absolute catastrophes (like those that seem to have followed in the wake of the extinction of our former moons), need not always be fatal. Indeed, they have much in common with financial crises. In both cases, those who are unprepared perish.

But those who have taken measures to protect themselves against sudden emergencies can stand the strain and survive.

And this remark offers me an excellent opportunity to introduce the real hero of our story and refrain from further

MAN

philosophizing, which is pleasant for the author but rather hard on the reader.

Alas! when the creature made its first appearance, it didn't look the least little bit like a hero, but very much like one of the baboons or chimpanzees or orang-outangs which regard us in such a melancholic fashion from behind the iron bars of the Zoo.

I do not mean to imply that the human race has descended directly from one of these man-like apes or that human beings are merely gorillas who have done rather well in the world and who have reason to feel slightly ashamed of their unfortunate grandparents. That would make the matter of descent altogether too simple.

But according to the best of our information, millions of years ago the chimpanzees and orang-outangs and baboons and we ourselves possessed one common ancestor. One part of the family evolved into something a little higher and finer and sometimes even a little nobler, while other branches contented themselves with remaining exactly what they had been in the days of the mammoth and the cave-bear, great big shambling creatures who live in the murky tenements of primeval forests or who are caught and put into cages to be shown to their gaping cousins of the big cities as a dreadful warning of the fate that awaits those who are too lazy or too incompetent or too dull to make the best of their opportunities.

As for the actual process of change which elevated man from the undignified position of a long-tailed quadruped, at the mercy of almost every one of its better armed neighbors, to the dignity of the tailless, two-footed master of the universe, there once more it is such a short time since we have been allowed to study that subject scientifically without running the risk of being burned at the stake for our troublesome curiosity that we are

THE TREE-COVERED EARTH

still profoundly ignorant about many of the most important details of this marvelous metamorphosis.

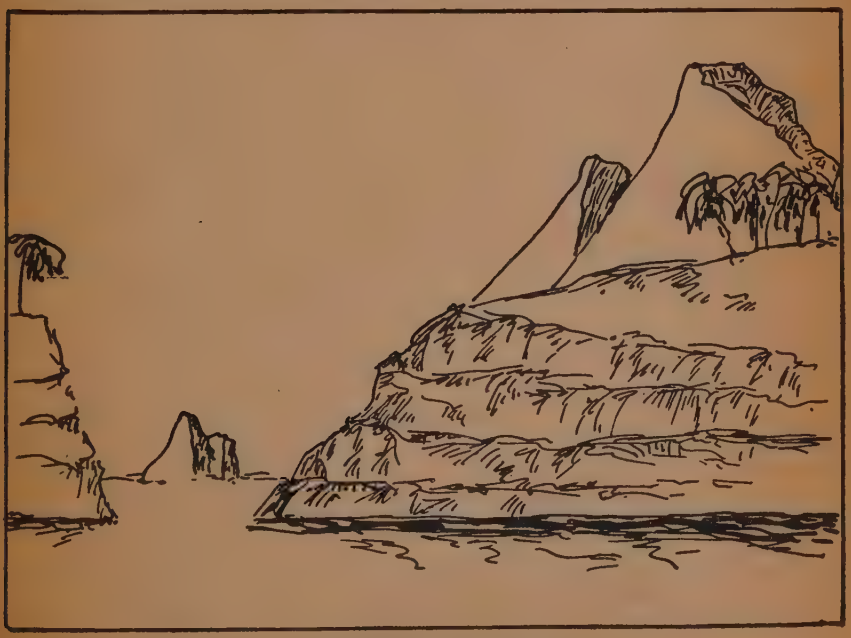
All the same, a sufficient amount of work has been done to make it possible for us to get at least a general idea of what happened when our great-great-grandparents took their courage into both their recently acquired hands and decided to break away from the dull routine of mere animal existence.

The period during which our ape-like ancestors came for the first time into international prominence was an era of a warm and even climate when there was more water on the earth than there is to-day and when small stretches of dry land, densely covered with forests, took the place of our present continents. These forests were inhabited by diverse tribes of a common simian origin. They were tree-dwellers and marvelous acrobats. For their safety depended entirely upon their ability to leap vast

distances without the slightest degree of error. Even if it were not exactly necessary for them to be nimble-witted, they were forced to be more so than their heavier armed enemies or be eaten by the latter.

Now if all had gone well and the world had remained as it was (which to the great horror of many honest people it never does) there is no reason why the simian race should not ultimately have inherited the earth and have become the undisputed rulers of this planet, as the gigantic reptiles and the gigantic mammals had been before them.

But some ten million years ago the earth seems to have suffered another change. As a result of this the waters receded somewhat and the land increased in size, while the general temperature of the world became slightly lower and the air became less moist. In consequence whereof, conditions became less favorable for vegetable life and soon (that is to say, after the inevitable hun-



THE WATERS RECEDE

dreds of thousands of years) vast stretches of land which since time immemorial had been covered with forests began to show occasional gaps. And finally the woods shrank until they had become mere little islands of trees, surrounded on all sides by grass-covered plains and snow-covered mountains.

It was then that our own ancestors had their chance.

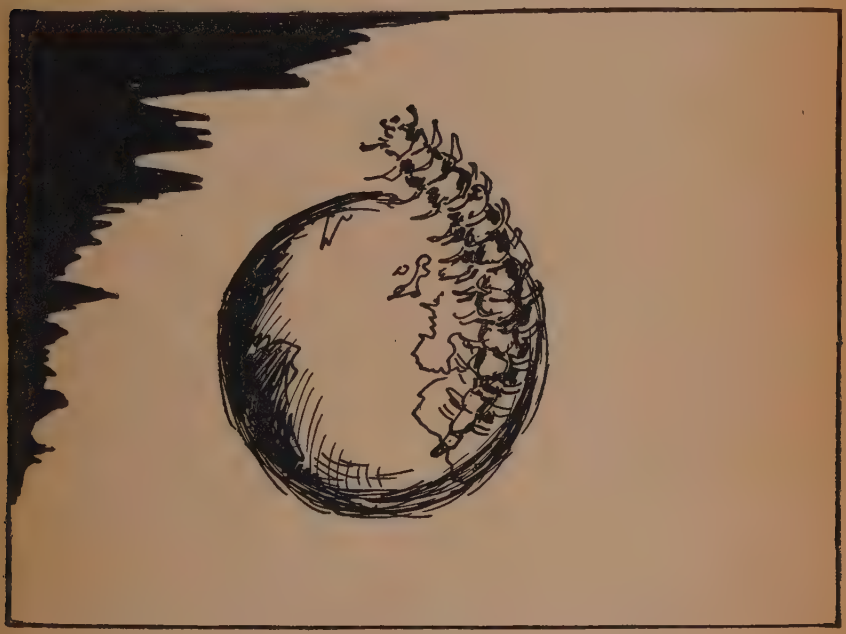
THE FIRST PAINFUL EFFORTS

Whereas until that moment they had been able to make an easy living, moving rapidly from one part of the endless forests to another, they now found themselves deprived of their old means of locomotion and were as helpless as railroad trains without tracks.

To make conditions worse, the ever increasing height of the mountain ridges was beginning to raise a series of barriers which divided the world into definite terrestrial compartments from

which there was no escape except for the birds and a few of the hardier varieties of insects and butterflies.

Under these conditions the law of the survival of the fittest began to operate with very remarkable results. By far the greater number of the ape-like creatures submitted to the inevitable. The more intelligent tribes, however, fought back.



THE MENACE

And they fought back with the only means at their disposal. They fought back with their brains.

It was then that our race passed through its most severe crisis and then that the future fate of mankind was decided for good and all.

It was then that the earliest ancestor of man turned inventor.

. . . . . .

Now when we use the word "invention" in the modern sense, we think at once of flying machines and radios and complicated

electric contrivances. But it is of quite a different sort of invention that I want to speak at the present moment. I want to tell you of those basic and elementary inventions which, curiously enough, only one sort of mammal seems ever to have been able to devise and which gave that particular species a chance not only to go on living when most of the others died, but furthermore to claim for itself and its descendants a position of such absolute preëminence that nothing will ever be able to shake it unless man, in his folly and greed, continues his present policy of violence and warfare and allows himself to be eaten out of house and home by some particularly industrious and prolific family of insects—while he himself is engaged in the usual pursuit of murdering his neighbors.

Right here of course one might interrupt me with the questions, "How about the inventive power of animals? Haven't the birds and the wasps and the ants and some of the fishes invented nests? Haven't the beavers become veritable architects and learned to build dams that are as efficient as anything made by human hands? Don't spiders construct all sorts of hunting apparatus that are the terror of their prey? What about the traps many of the insects dig to capture their prey?" And so on and so forth.

To which I could only answer yes. The business of inventing is not exclusively restricted to that part of the animal kingdom which is known as Man. Several of his rivals have also "invented" things. But there is a vast difference between the inventions of ordinary animals and those of our own species.

The ordinary animals have never originated more than a single new idea. That one effort seems to have exhausted their imaginative powers. Thereafter they merely repeated themselves in an absolutely monotonous and mechanical fashion.

The nests and webs and dams they are building in the year of grace 1928 are not different from the nests and webs and dams

they made in the year 192,800,000 B.C. If we allow them to survive, which is doubtful, they will still be building the same nests and webs and dams 192,800,000 years hence. For their so-called inventions are merely part of their daily quest for food, as is shown by the fact that those same animals, in a state of captivity, cease almost immediately to construct anything at all and happily live upon the fare which is provided for them by their keepers. Whereas man seems to have realized at a very early moment that there was something more to life than the mere business of getting enough to eat and to drink; that he could not hope to devote himself to matters of the spirit without a great deal of leisure; that this leisure could be achieved only by freedom from toil and drudgery; that this freedom from toil and drudgery could be accomplished only by an endless variety of "inventions" which had to be based upon the unlimited mul-

THE INVENTIVE ANIMALS

tiplication and extension of those few and slender powers with which nature had endowed him at the time of his birth.

That is a pretty big sentence, but it is the last of the big sentences in this book, and, furthermore, it has got to be a big one. One cannot discuss the problems that lie at the very root of existence as if one were talking about the weather or the coming elections. It takes big words to explain big ideas. But once you understand what I am trying to say on this page, you will understand everything else in the present book and so it won't do you any harm to reread the last hundred words a couple of times.

The human race, as we know it at present, started with one enormous initial advantage. Its ancestors, through their mode of living among the branches of the trees, had been obliged to develop a high degree of mental alertness and quickness of decision long before any of the other animals had been placed in a similar desperate position. With those others, brute force had been pitched against brute force. With the apes it had been a question of nimble fingers and even nimbler minds, holding their own against claws and beaks that could break a tree into splinters.

When through the disappearance of their former haunts these creatures had suddenly been forced to change their mode of existence, they had already accumulated such terrific versatility in the use of their hands and feet that it was comparatively easy for them to use their hind-legs for the purpose of standing upright, while their fore-feet supported their bodies among the low shrubs and the high reeds through which they must now begin to move in quest of food.

When finally they found themselves almost completely deprived of their verdant bungalows and were forced to dwell entirely in the plains, they were no longer a mere tribe of tree-dwelling animals but a strange new sort of creature which was rapidly learning the incredibly difficult art of walking on its hind-legs without any support whatsoever and which was therefore

THE COMING OF THE GLACIERS

able to relieve its fore-paws from all further duties as auxiliary engines of locomotion and could use them entirely for a number of purposes, like "holding" and "carrying" and "tearing," which thus far had been performed in a clumsy and most unsatisfactory fashion by the teeth of their powerful jaws.

That was the first step along the road of progress and it was directly responsible for the second one, to which the bulk of this book is devoted, and which consisted in that gradual process of multiplication of the powers of our feet and hands and eyes and ears and mouth, and in strengthening the endurance of our skin, through which we have attained our present superior position in the animal kingdom and which has made us the undisputed rulers of the star that serves us both as a home and as a prison.

. . . . . .

But that was not all. At the very moment when our ancestors were rudely put before the choice of remaining what they were and perishing, or becoming something a little better and surviving, nature came to their aid. For not only did the climate change sufficiently to bring about a shrinkage of the forests, but the lessening of the available water supply and the increasing height of the mountain ranges (and mayhap some other reasons which we have not yet discovered) caused such a sudden decline in the general temperature of the earth that another of those so-called "glacial periods" took place, which ere then at regular intervals had covered the greater part of both the northern and the southern hemisphere with thick sheets of ice and snow and had forced all plants and animals to withdraw to a comparatively narrow strip of land along both sides of the equator.

It is a fact quite often overlooked in our modern times (when work has become almost the sole relief of the boredom created by a purely mechanical civilization) that everything that exists is innately lazy. Since it is the business of living matter to go on

ICE

living, it will make very great efforts to survive. But once this primary duty has been attended to, there is not a plant nor an animal nor even a piece of coral which does not greatly prefer peace and quiet to activity and bustle. No lion or tree or shrimp ever works when he or she or it can enjoy the agreeable joys of doing nothing at all. And man too would never have achieved his present great victories if he had not been spurred into action by the brutal necessities that were inevitably associated with those endless periods of time when only one-eighth of the surface of the earth was inhabitable.

Never before or afterwards has man made such enormous strides in every field of development as during those ghastly stretches of time when glaciers crept down upon him from all

sides, when the summers had shrunk to a mere handful of days, when all the land from the North Pole to the Alps was one vast ice-field.

We hear a great deal about that proverbial "school of hard knocks" which is supposed to be the best of all possible institutions of learning. To judge, however, by the results, the "school of the glaciers" was the most thoroughgoing training-school which the human race ever attended.

Article I of its icy curriculum read: "Thou shalt either use thy brain to the utmost possibility of its development, or thou shalt perish."

Our ancestors of those long forgotten days were low-browed brutes, evil-smelling savages, creatures that were very little different from most of their animal neighbors. But we can forgive them a great deal when we remember that they had the courage to take up the uneven battle against nature and were willing to fight it out to a victorious finish against odds that nowadays would seem hopeless.

And how they did this by the very simple process of multiplying to an almost unlimited degree the powers that lay dormant in their hands and feet and eyes—that I shall now try to tell you.

CHAPTER II

From Skin to Sky-Scraper

ALL inventions that have ever been made serve the general purpose of assisting man in his praiseworthy effort to pass through life with a maximum of pleasure in exchange for a minimum of effort.

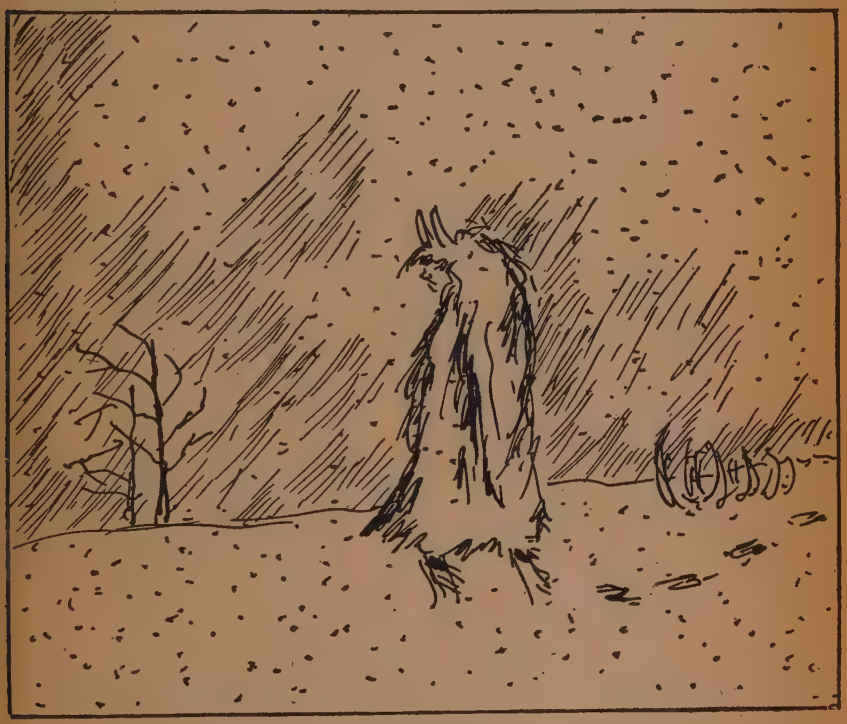
But some of them are merely multiplications (or extensions or intensifications or augmentations) of certain physical attributes, such as "speaking" or "walking" or "throwing" or "listening" or "looking," while others are the result of man's desire to keep his body and his faculties in decent comfort and repair.

The division which I here offer is a very loose one. Many of the inventions overlap. But the same is true of all attempts at scientific classification. Nature herself is hopelessly complicated and man happens to be the most complicated of all her achievements. As a result, everything connected with man or his desires or his accomplishments is a vast mass of the most extravagant contradictions.

I feel it my duty to tell you this, for if you happen to be a thoroughgoing classification fan, you will discover a great many things in this book which will irritate you most terribly and you had better exchange it for a handbook of botany or a

couple of time-tables. All of which are guaranteed to be without error or exaggeration.

For example, take the inventions connected with man's skin. Do they belong to the first division—to the inventions which are connected with survival—or to the second one (which I hope



(The Skin)

THE FIRST COAT

to write about afterwards)—to the inventions connected with "maintenance and repair"? I really don't know, but I have decided to include them in the present volume. Nowadays we take them so absolutely for granted that it would seem as if they belonged in the second department and served no other purpose than that of "maintenance." But in the beginning they had more to do with keeping men from becoming a defunct species of ani-

mal than almost any other agency. And so I shall include them here.

And here goes!

Ever since the beginning of time, animals had gone about in a state of complete nakedness. However much they had suffered from the cold, none of them had ever thought of protecting itself against snow and icy blasts by reënforcing its own skin with a layer of artificial heat, provided by the skin of one of its departed brethren. They sometimes sought the shelter of a rock during a blizzard or a hailstorm, but that was quite as far as they went.

The idea of putting on a coat when it is cold seems so incredibly simple that we can hardly imagine a time when man had not yet learned that one could assure one's body against sudden changes of temperature by covering it with a layer of animal or vegetable matter, either in the form of the skin of a dead animal or in that of a woolen blanket or a linen coat or a mantle woven out of the grass or the leaves of a plant or tree.

But you will notice throughout this book that very often the least complicated innovations were the last ones to be thought of and that it took an enormous amount of perseverance and ingenuity on the part of hundreds of thousands of bright people to evolve even the simplest of simple devices and carry them to a practical solution.

Of course we never know the names of those true pioneers of progress. But there must have been some one who was the "first" to venture forth clad in the hide of a cow or the pelt of a bear, just as in our own times there was one "first" person to talk into a telephone and a "first" person to listen to the first weak sounds of a written telegram. And I feel convinced that the "first" man to appear in an overcoat caused a great deal more commotion than the first man who drove down Fifth Avenue in a horseless carriage.

Very likely he was mobbed.

Even more likely he was killed as a dangerous sorcerer who tried to interfere with the will of the gods who on the day of creation had decided that man should ever suffer from cold when it was winter and from heat when it was summer.

Skins, however, must have been galore in a world that lived by hunting and the new invention had come to stay, as you may see for yourself by looking out of your window.

But the ordinary skins of ordinary dead animals suffered from several disadvantages. In the first place, they were terribly smelly, as prehistoric man had no way of preparing them except by letting them dry in the sun. The stench, however, can't have meant very much to people used to spending their days and nights among the decaying remnants of all their previous meals. But they were apt to crack and they did not fit the form of the body very well, in consequence whereof they were full of draughts and of no earthly use in a storm or a blizzard. And so the Inquisitive Ones (the only people who have ever done anything worth mentioning for the human race) said to themselves: "So far, so good, but can't we find a more comfortable substitute for our substitute-skins?" and they set to work and produced a number of "just-as-good" articles which have played a tremendous rôle in the history of human progress. I refer to those products which we know by the names of cotton, wool, linen and silk, all of which seem to have come to us from Asia.

Perhaps you will object that the word "seem" occurs a little too frequently in these pages to make you feel that I have the slightest scientific confidence in the statements I am making. Well, you would not be so very far wrong. I am like a person trying to solve an intricate puzzle in a dark room. Up to fifty or sixty years ago, we did not even know that there was such a thing as prehistoric history. We said: "Civilization begins with Abraham leaving the land of Ur," or if we were very auda-

cious, we went 2000 years further back and boldly proclaimed: "Civilization begins with the Egyptians and the Babylonians."

We knew, of course, that Chinese history was a great deal more ancient than that of western Asia and northern Africa, but the Chinese were heathen and lived far away and therefore we rarely bothered about them unless we happened to write about the Opium War or the sack of Peking by the Allies, when we gave them half a preliminary page.

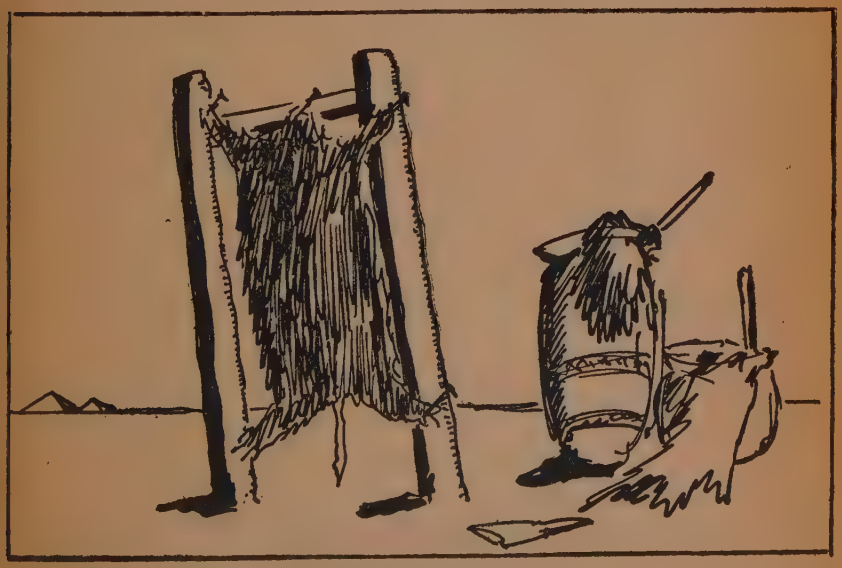
Gradually, however, a few people reached the conclusion that this idea of making history start on a definite day in the year 4000 + B.C. or the year 2000 + B.C. was a little absurd—just a little childish. And they began to dig among the rubbish heaps of Denmark and they lit an occasional candle in the caves of southern France and northern Spain and they took care that the queer statues and the broken skulls that were found in the soil of Austria and Germany were no longer sold to the junk man. Until they found themselves possessed of so much and such highly interesting material that they were forced to confess that those cordially despised ancestors of the glacial age had not been quite such ignorant brutes as had always been supposed and that the much vaunted civilization of the Egyptians and the Babylonians had been merely a continuation of certain forms of culture which had been devised by still other tribes of which every trace had been lost thousands of years before the building of the pyramids.

To-day if it is true (as some learned professors claim) that we have discovered the key to the mysterious inscriptions that were found in and around the caves of southern France, we can extend the period of recorded history by at least 10,000 years and instead of speaking of fifty centuries of human progress, we ought to speak of one hundred and fifty centuries.

But once more I must warn you that this whole field of knowledge is practically unexplored and that we know as little about

the state of Europe or Asia in the year 15,000 B.C. as we know about the bottom of the ocean. No sensible person, however, but feels that a perfect knowledge of the bottom of the ocean is merely a question of time; and the same holds true for the so-called prehistoric era. Give us plenty of serious investigators and a few years of peace (bombs and shells are not the best things in the world for hidden treasure-rooms filled with earthen pots and pans) and we shall surely possess as much information about the people of the last glacial period as we now have about the subjects of King Tiglath-pileser.

For example, we know from certain prehistoric pictures (and some of our remote ancestors were remarkable artists) that man used to clothe himself in the dried skins of dead animals. But at what precise period he changed his crudely prepared skins into regular leather, that is something upon which we have no definite information but which we can find quite easily by using



(The Skin)

TANNING

a little common sense and by inspecting the circumstantial evidence that is at our disposal.

Hides are changed into leather through a process which we call "tanning." "Tanning," according to the dictionary, "is a process through which we are able to convert raw hides into leather by soaking them in liquids containing tannic acids or by the use of mineral salts."

The next question is: "Who were the people of ancient times who knew most about 'converting raw hides into leather by the use of mineral salts'?" and the answer is: "The Egyptians, whose religious convictions obliged them to preserve the bodies of their dead for the greatest possible time and who therefore perfected the art of embalming long before any of their neighbors had ever even thought of such a possibility."

And when we go to the valley of the Nile, we find as a matter of fact that the Egyptians were expert leather workers centuries before any of the other nations of the ancient world and that the shoemaker's shop (which for all the world looked like one of those quick repair establishments which are so popular in our modern cities) was one of the earliest of the pictures that appeared inside the tombs of defunct Theban kings.

From Egypt the tanner's art then spread to Greece. But the Greeks were people of a delicate taste, and philosophers can discuss the problems of existence just as comfortably and even more comfortably in a woolen tunic than in a leather jerkin. Wherefore the leather industry never made much progress in that land and hastened to Rome, where every other man was a soldier who needed stout sandals and helmet straps and cuirasses, all of which had to be made out of the hides of cows and sheep, duly prepared to withstand the heat of the Sahara and the dampness of Scotland.

In the meantime, in the same land of Egypt, several other skin-substitutes had been carried to a high degree of perfection.

In the valley of the Nile, as well as in the valleys of the Tigris and the Euphrates, people were more in need of protection against the heat than of protection against the cold. Hence at a very early age they tried to find a cooler sort of garment than the skin of a donkey or a goat. And after thousands of years of experiments with different sorts of grass and the leaves of trees, woven into all sorts of garments, they came to the con-

(The Skin)

THE FLAX GROWERS

clusion that the stalk of *Linum usitatissimum*, which we call "flax," was best suited for the purpose of future textile experiments.

It seems to be the usual opinion that one-half of the world lived in complete ignorance of what the other half was doing before the introduction of the telegraph and the modern newspaper. The contrary is true. Both the telegraph and the newspaper serve quite as much as means for the propagation of erroneous information as for the spread of reliable news. A hun-

dred centuries ago such highly interesting items as what leading cave-dwellers of the Dordogne had eaten for supper night before last, or what the lake people of Switzerland intended to wear as their fall costumes would hardly have found their way to the tents of the mammoth-hunters of lower Siberia. But whenever anything of real importance happened, whenever a new invention had made its appearance, that increased man's power over nature, it seems that the Chinese knew about it almost as soon as the Cretans or the people of the Atlantic seaboard. I do not mean to imply that all those who heard the news made equally good use of the information. No more than we do today. Indifference and ignorance, but mostly the fear of the unknown, have ever been the enemies of reasonable progress. But that inventions (if they appealed to everybody's interest) could spread with surprising celerity is a fact which the evidence of caves and graves bears out beyond the shadow of a doubt.

Otherwise we should not have found evidences of flax culture along the shores of the Swiss lakes at the same time that it was being grown in the valley of the Nile, for the two places were at different ends of the inhabitable world. But when and where this plant was first raised, that again is one of those things which we shall never be able to find out, and the same holds true for cotton, of which we first hear in Persia and a few years later in Mesopotamia.

According to Herodotus, cotton had come originally from India, but the planting of the crop and the harvesting had been too complicated to let it attain the popularity of either flax or wool as a suitable material for the manufacture of substitute skins for the masses. This sounds familiar to modern ears, but then the problem is as old as the hills and dates back to the latter half of the Stone Age.

In the beginning "mass production" had hardly been necessary. During the glacial periods people had been forever on

the move. Their diet and the conditions under which they lived were worse than those of the poorest slum-dwellers of the year 1928. The majority of the bones we have found in caves and river beds show signs of those uncomfortable diseases which are inevitable when people sleep in damp quarters and which drag their victims to the grave long before they have reached the age of forty.

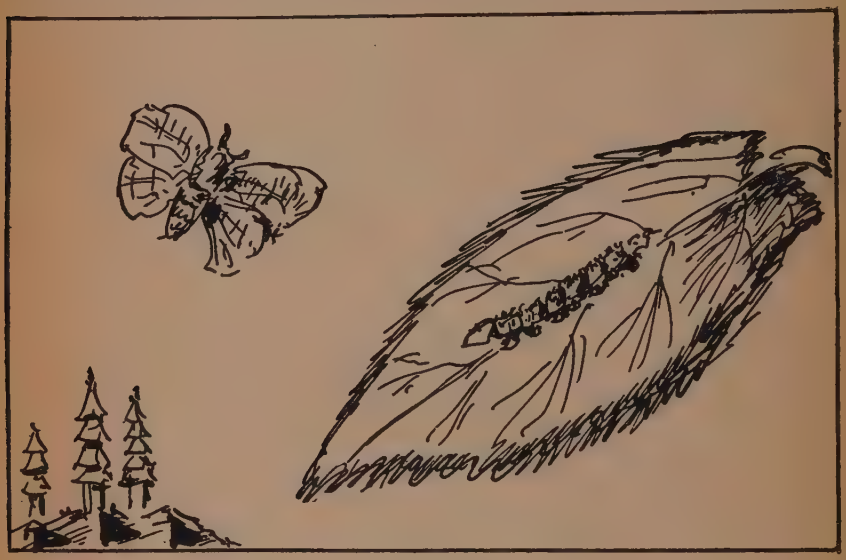
Infant mortality seems to have been as high as it was in Russia during the days of the Tsars—a little over 50 per cent. An unusually long or cold winter would depopulate whole countrysides, as it does to-day among the Esquimaux and some of the Indians of northern Canada. The number of people alive at the same time therefore remained very small; but with the opening up of the large granaries of the Nile and the Euphrates, all this changed. Then at last man could breed at will and large accumulations of human beings could inhabit the same spot. Cities began to develop and the inhabitants of those cities had to be provided with a form of clothing that should at once be cheap and plentiful.

The woolen industry was the answer. Credit for the first woolen garment should undoubtedly go to the peasant who first realized the possibilities of domesticating the doleful creatures which the Romans called "ovis" and which we call "sheep." This first shepherd must have lived somewhere among the mountains of central Asia. For it was from Turkestan that the wool industry spread westward until by way of Greece and Rome it reached the British Isles, which for over a thousand years were to remain the greatest wool-raising center of the world and were to use this article of export as an economic shillelagh with which to threaten all their neighbors into submission.

For all the rest of the world (and for a long time after its discovery, even the people of America) depended for its supply of raw woolens upon the favor of England. The English

knew this and made as shrewd a use of their monopoly as any other country that has its neighbors at its mercy for some staple product of consumption.

The mediæval ballads and sagas are full of sentimental references to spinning and weaving, but they should not close our



(The Skin)

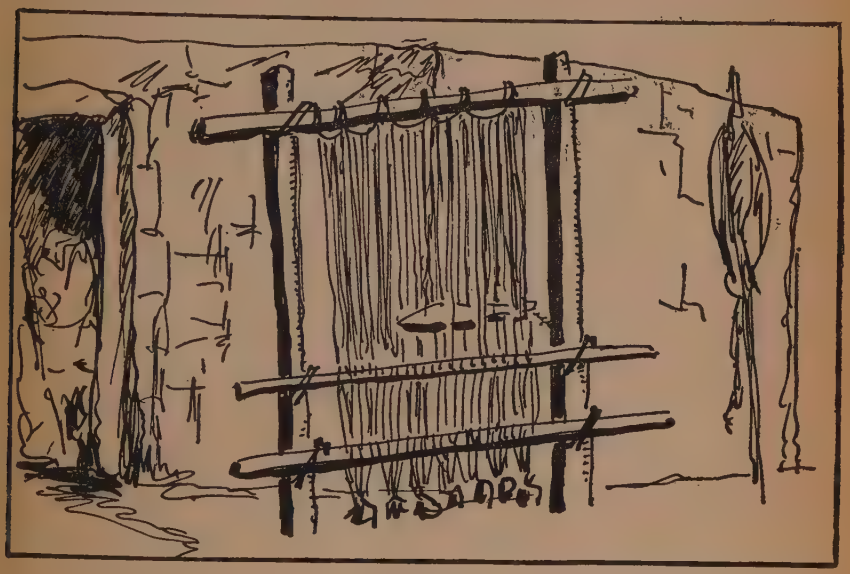
THE SILKWORM

eyes to the fact that the innocent though fleecy lamb has caused quite as much blood to be spilled as half a hundred diamond mines or oil wells.

In this particular wool had a very different record from another substitute for the skin which was of even more modest origin. I mean the silk spun by a miserable worm with the grandiloquent name of *Bombyx mori.*

The appearance of some substance like silk upon the markets of that part of the world devoted to Vanity Fair was, of course, unavoidable. For man not only is a lazy creature but also is incredibly vain. What would be the use of having money

in one's purse if one could not provoke the envy of the neighbors by a display of rich and rare apparel? When all the world goes forth dressed in linen and woolens, there is not much fun in belonging to the woolen-brigade oneself. No, the poor rich were sadly pressed and had to choose between discovering a new



(The Skin)

THE WEAVERS

but expensive way of keeping themselves warm or going about without any clothes at all.

At that very moment the Chinese insect came to their rescue, for in those ancient days its product was worth its weight in gold.

Bombyx mori hailed from Asia. His cradle stood in the far eastern corner of Asia and to the Chinese belongs the honor of having been the first to recognize his eminent services to the cause of beauty and civilization. They were so proud of their discovery that they declared it to be of divine origin and according to tradition, no one less than the lovely Si-lung, the wife

of the famous emperor Huang-ti (who lived more than a thousand years before Moses) was the first to make a scientific study of the famous little creeping creatures whose tiny glands eject almost a thousand yards of silken thread when the time has come for them to retire into the privacy of their cocoons.

And so delighted were the sons of Han with the labors of their beloved empress that they decided to keep the manufacture of silk a holy secret. In this they were successful for more than twenty centuries. Then the Japanese sent a delegation of Korean traders to the Holy Empire who induced a few Chinese girls to come to Japan and teach their cousins the noble art of silk weaving.

A short time afterwards a Chinese princess, hiding the seed of the mulberry tree and the eggs of *Bombyx mori* in her silken headdress, smuggled the precious treasure out of China and carried it to India. From there began its victorious westward voyage.

The inevitable Alexander the Great seems to have heard of it during his famous eastern campaign. The equally inevitable Aristotle mentions the worm. A few centuries afterwards those Roman ladies of fashion, whose husbands could afford this smart luxury, always wore silk.

But silk remained almost as rare as platinum is to-day until the end of the sixth century of our era, when two Persian monks were able to smuggle a small colony of silkworms, carefully hidden in a bamboo tube, past the Chinese frontier guard. They carried their contraband in triumph to the Emperor of the Eastern Roman Empire in Constantinople and that city then became the center of the European silk trade.

When the Crusaders plundered that holy site, they filled their trunks with bales of stolen silk and in this way, almost thirty centuries after its invention by the Chinese, the silk industry was introduced into the western half of Europe. Even

then silk remained a great luxury and it was a matter of pride for a Burgundian prince that his daughter's dowry contained "a pair of real silk stockings" and even 600 years later, a silly and vain woman like the Empress Josephine could practically ruin her husband by the large number of silk hose which she saw fit to order while he had gone forth to conquer Europe.

This situation was bound to come to an end when every woman began to feel that she, too, had the right to dress herself like the wife of the Emperor of the French. From that moment on there were not enough silkworms on the whole of the planet to supply the demand of the new industrial democracy. The ever obliging chemists were then called upon to fill the void. They set to work and soon favored us with an artificial form of silk which was made out of the same substance as our modern paper. It was rather terrible stuff and it would not last. But in an age of quick turn-over that worried very few people and nowadays women go about dressed becomingly in garments made out of wood.

So much for the different materials which were used as substitutes for the cowhide of our earliest ancestors. These materials have varied greatly, in cost and in texture and in art, but it is a curious fact that the basic idea underlying our wearing apparel has not changed at all since the day when the first man robbed a horse of its skin and used it for the purpose of making his own hide feel more comfortable.

Recently, however, the terrific extreme of cold to which aviators who fly at high altitudes are exposed, has led to the invention of "flying suits" which are kept at an even temperature with the help of a small electric battery.

The invention of even smaller batteries, which can be carried in our vest-pockets, will probably revolutionize the clothing industry before the end of another fifty years. Then, instead of

(The Skin)

THE BATTERY JACKETS

borrowing each other's overcoats, we shall drop in at the house of a friend to ask him to let us recharge our battery, while we smoke a cigarette before his electric grate.

To-day that sounds slightly absurd, but I am not a very old man and yet, when I was young, we would have roared with laughter if some one had suggested that in the year of our Lord 1928 every citizen would be racing around in his own little private locomotive. And so why not expect a coatless age that shall save us from carrying an extra burden of cowhide or coonskin and shall do away with the insufferable nuisance of the cloak-room brigands?

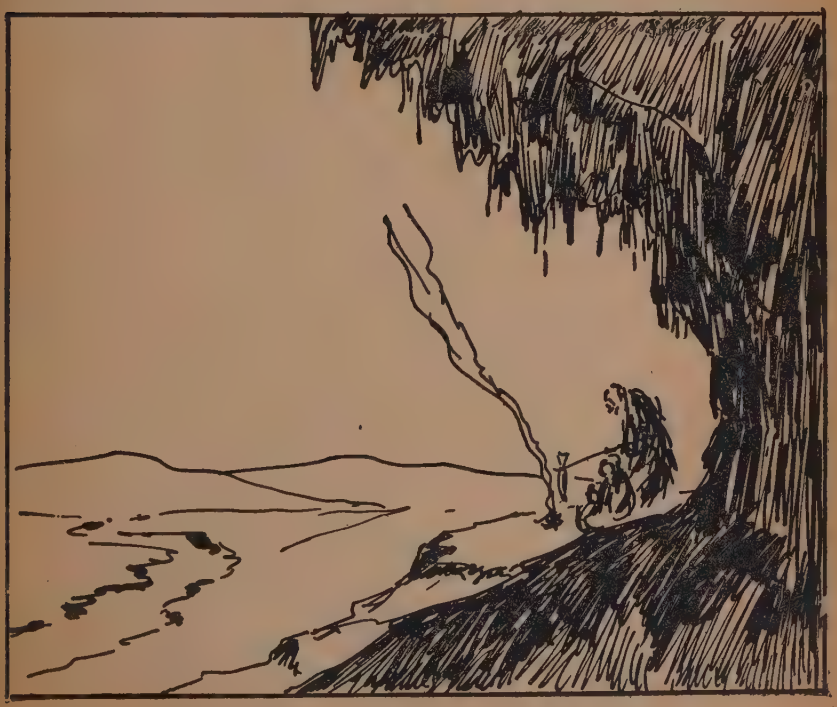
A pious wish.

May it soon come true!

. . . . . .

And now for another invention which is also closely connected with man's desire to increase the power of resistance of his own skin, but an invention of quite a different sort.

It would be easy to say that this, too, had been the result of an attempt to protect the human body against heat and cold, but this would not be entirely true. Other elements entered into the making of that curious substitute for the skin which we call a house. Chief among those influences was the habit of all mammals to care for their young for a longer period of time than any of the other animals. For this purpose they needed a safe spot where the whole family could be kept together for two or three months and where they could be taught the rudiments of their papa's and mamma's profession until they



(The Skin)

THE SHELTER OF THE ROCKS

were old enough and big enough to set up in business for themselves.

At first they found desirable quarters in hollow trees or inside those caves that had been formed through the action of the water and had become free for occupancy when the oceans receded and the rivers were confined to narrow beds that lay from thirty to forty feet below their ancient levels.

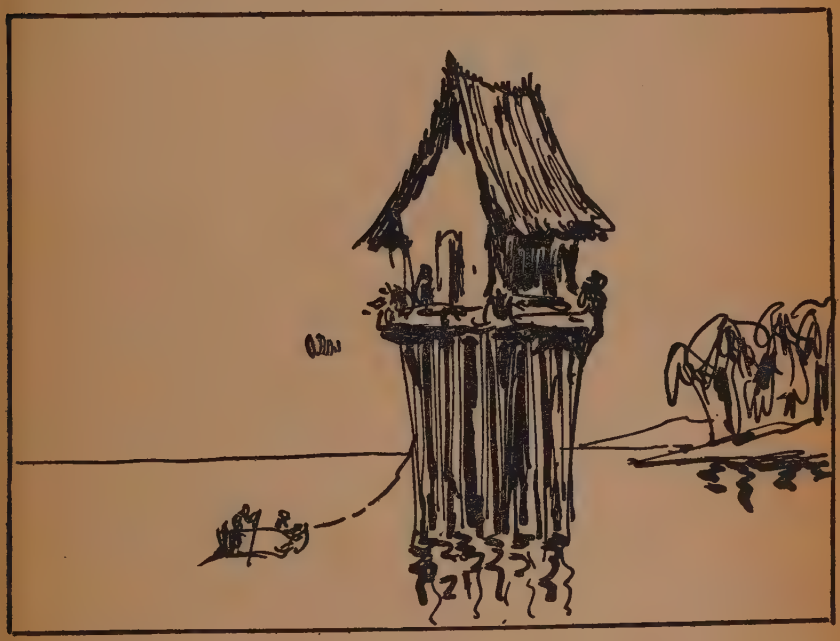
(The Skin)

THE HOUSE MADE OF ICE

But these primitive homes were not very attractive. They were filled with millions of bats, for daylight rarely penetrated into these dark grottoes. What was much worse, saber-toothed tigers and gigantic bears, belonging to a species now extinct, also considered themselves extremely desirable tenants and the mixtures of human skeletons and animal bones which we find deep in the gray dust of those cavities tell grewsome stories of the desperate battles that were then fought for a dwelling-place in which to-day we would hardly stable our pigs.

Caves, therefore, did not remain popular very long. A few of them were retained as places of worship, but the vast majority were given up as homes just as soon as some one had discovered how to make himself a substitute cave, or, as we would now say, just as soon as he had built himself a "house."

In his subsequent search for protection from cold and heat, man has devised some exceedingly strange contraptions. In one



(The Skin)

THE HOUSE MADE OF LEAVES

part of the world he has constructed houses out of square blocks of ice. In other parts he has woven his shelter out of the branches of trees and has covered them with grass and with leaves.

The most primitive house of all was the lean-to. It has survived as a makeshift for hunters suddenly overcome by nightfall,

and as the only place of residence of certain of the least civilized natives of South America and Australia.

Next came the houses made out of baked mud and covered with straw. Then the house with the rough wooden frame. This developed into the so-called pile-dwelling of which we have found remains in many parts of the world, and which is still in common use in certain tropical regions well provided with lakes and rivers.

It used to be thought that these houses on stilts had been constructed mainly for the purpose of safety. But there was another consideration which made people take to the water. One of the first evidences of a beginning sense of decency (which really means a beginning sense of civilization) is a desire for the cleanliness of one's own person and of one's clothes and immediate surroundings. Europe is apt to laugh at us in America for our insistence upon bathrooms and sewers, and perhaps we sometimes overdo the business a little. Athens was no mean city, although the pigs in the streets were also the garbage collectors, and mediæval Paris made certain very definite contributions to knowledge and art without wasting much time or money upon the problems of sanitation. Nevertheless, other things being equal, it is more agreeable to live in a country that prides itself upon its neat back yards than in a region where family and fertilizer dwell happily together underneath one and the same roof.

People seem to have known this 20,000 years ago as well as they do to-day and those who were more squeamish than the others began to build their houses fifty or a hundred feet from the shore. The roof overhead protected the lodgers against the sun and the rain, while the waters underneath acted as a dump-heap and the little fishes played the rôle of White Wings —a truly ideal combination.

This was a great improvement upon what had gone before,

but people were still forced to share the same barracks for the sake of greater safety. However, as the problem of survival had become a little less urgent, they took a second step forward and discovered the charm and the spiritual advantages of privacy.

(The Skin)

THE MODERN CITY

For privacy is one of the greatest of all human goods, but unfortunately it comes high. It is a luxury which only the very rich can afford. Nevertheless, the moment a family or a nation has reached a certain point of well-being, it immediately clamors for the sovereign right to be alone. And that is the way individual houses came to be built.

During such periods of affluence, people would no more think of sharing each other's homes than we would think of sharing

(The Skin)

SUMMER HOME

each other's overcoats or toothbrushes. Now and then, as in ancient Rome, whenever too many slaves had gathered together on too small a spot, the inevitable tenement houses made their appearance. But the people who crowded together in the dark dungeons which the Romans thought good enough for the poor peasants who had come to the big city in the hope that there they would be less miserable than on their war-stricken farms, never liked those suffocating barracks and never took root in the slums. Just as soon as they could, they went back to the "one-family house."

During the Middle Ages in certain parts of Europe the respect for a man's living quarters became so great that "My house is my castle" was more than a mere phrase. It was a political program and stood writ into more than one Great Charter.

But our own modern times, by erecting vast workshops near the mouths of convenient coal mines or along the banks of

profitable harbors, have forced the people to return to the mode of living that was originally practiced by the cave-dwellers but was given up by them as unworthy of decent human beings. As a result, the big cities of the West have become gigantic accumulations of artificial skins, piled one on top of another without the slightest respect for the sacred right of privacy of the individual and offering the average citizen as much seclusion as that enjoyed by a sardine.

Fortunately a great change is coming over the world. Everywhere people are in open rebellion against the degradation of the human ant-heap. Most families are still too poor to afford more than a couple of rooms in a stone or wooden five-decker, and they must share their sleeping and eating quarters with several hundred perpendicular neighbors. But those who can do so have developed a novel scheme of living which is vastly superior to that of their grandparents and which makes them the equals of certain sorts of birds. They migrate. They have

(The Skin)
WINTER HOME

two sorts of shelter. One is located in semi-tropical regions where they can spend the winters, duly protected against the rigors of the north wind. The other is built amidst the forests of the North, where they can escape from the sultry heat which during the summer months turns the sky-scraper-lined streets of our cities into thoroughfares of Hades.

At present it seems only a dream that some day practically all of mankind will be able to move up and down with the seasons. But in America that dream is fast becoming realized by an ever increasing number of people.

Ten thousand years from now it may appear to our descendants that we of the twentieth century, at least in the matter of mere living, were still contemporaries of the lake-dwellers and the cavemen and the ruins of New York and Chicago will convince them that those rubbish heaps of stone and steel were probably constructed during the latter half of the Stone Age.

. . . . . .

It was one thing to find a shelter against the snow and the rain, but it was not quite so easy to keep those shelters warm.

Hence the invention of the house was closely followed by the invention of the fire as a means of keeping warm. Open fires, the original form of heating, have survived until our own day, but now they are used chiefly for ornamental purposes, for they are quite as uncomfortable in the year 1928 as they were in the days when they also served to prepare the daily dish of fried mammoth steak, burning one's toes and allowing one's back to freeze as unconcernedly as if there were no fire at all.

The crude ovens of some of the early Scandinavian tribes show that even then people were looking for something a little more practical than a mere log.

Unfortunately, the Egyptians and the Babylonians, the most intelligent among the ancient inventors, lived in such agreeable

(The Skin)

CENTRAL HEATING

climates that they did not have to bother about stoves. But the Greeks, who, like sensible people, knew that high thinking cannot exist together with uncomfortable living, seriously put their minds to the task of devising a more satisfactory method of heating and bethought themselves of hot air as a means of keeping their substitute skins at an even temperature.

The palace of Cnossos (the capital of Crete, which ruled the eastern part of the Mediterranean a thousand years before the birth of Christ) was provided with radiators. As for the Romans, who, like all true Mediterraneans, abhorred the cold, they arranged their houses in such a way that all the floors and the walls could be heated by means of a stove that stood outside the premises and was kept at full blast by a couple of slaves

who acted as furnace-men and saw that there was a steady and even flow of hot air throughout the premises.

During the third and fourth and fifth centuries, however, when Europe was overrun by savages from the heart of Asia who had a deep contempt for what they called "softness" (the same "softness" that had kept them outside of Roman walls for more than 600 years), comfort—in the Greek and Roman sense of the word—disappeared from the face of the earth. The majority of the old Roman houses went to ruin. Temples were used as stables for horses and oxen. The former summer residences of Roman patricians were carted away to be turned into fortifications. Old theaters were transformed into miniature villages. And the radiator-systems of the senatorial villas were allowed to go to pieces.

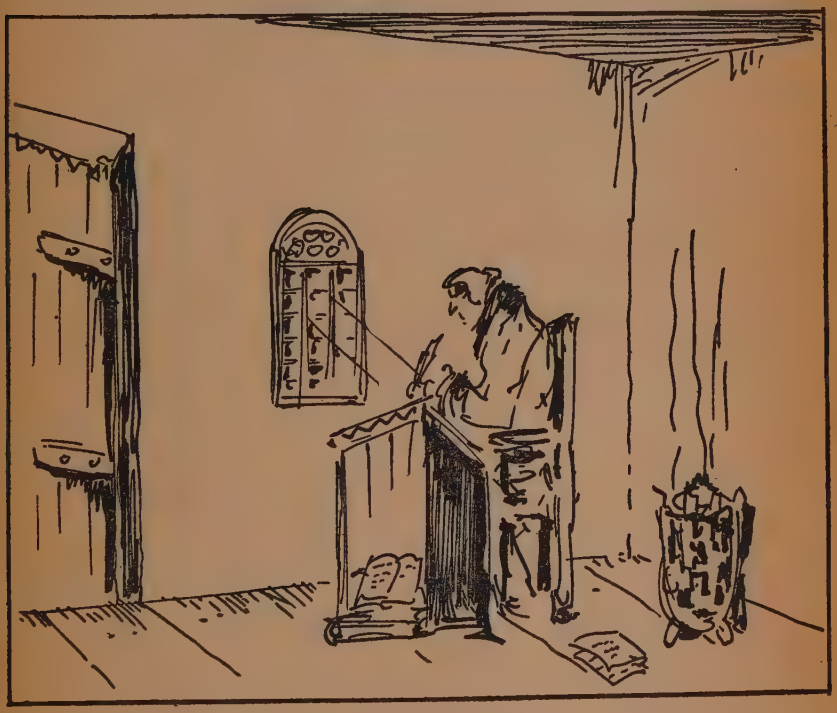
With a return of law and order, people once more moved into houses of their own; but for more than a thousand years they either froze altogether or tried to keep their rooms warm with the help of braziers filled with charcoal, a method of heating which merely accentuated the cold and forced them to keep their hats and coats on even when they went to bed.

During the fifteenth and sixteenth centuries, conditions were almost as bad. It is very pleasant to read about the glories of the great Sun King. But we envy His Majesty a little less ardently when we realize that, although he was considered the richest and most powerful man of his time, the good king spent his days in a palace that could not possibly be kept warm, that the stewed fruit froze on his own dining-room table, and that his courtiers, when they decided to wash themselves (which was rarely), were obliged to attack the water pitcher with an ice pick.

Finally, as a supposed improvement upon the charcoal brazier, some one returned to the open fireplace which had already been old stuff in the glacial epoch. But this time it was provided with a chimney, a specially constructed shaft which

was supposed to convey the smoke from the grate to the outer air by way of the roof.

At first the chimney was merely a hole in the wall itself, but at the beginning of the sixteenth century (after 300 years of experiment and failure) we hear at last of regular chimneys which

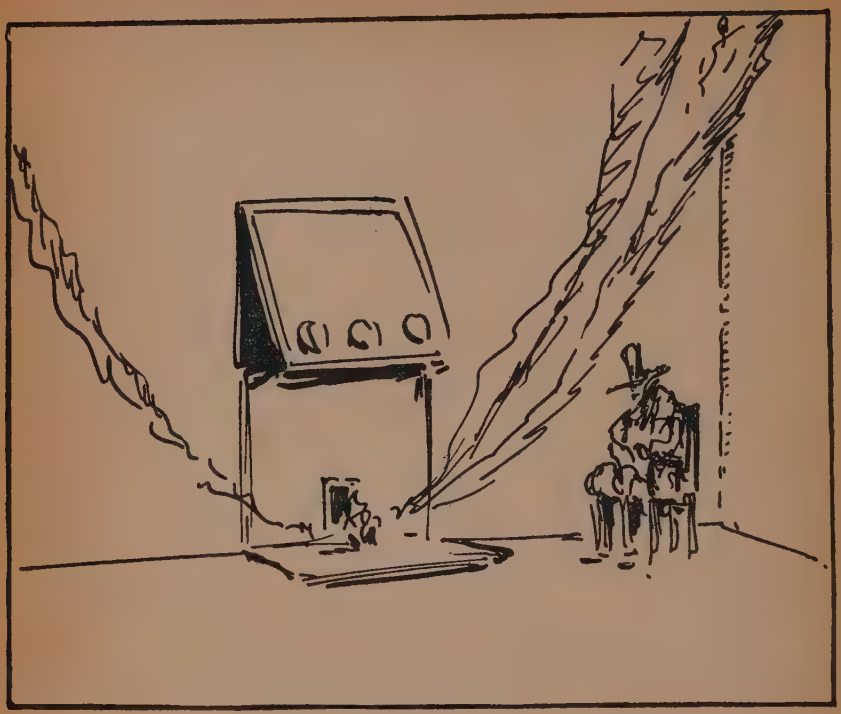


(The Skin)

THE CHARCOAL BRAZIER

looked like those we use to-day and which were capable of causing sufficient draught to take care of almost any fire.

Even then this method of keeping the substitute skin warm was far from satisfactory, and during the next ten generations both pauper and prince continued to choke and freeze in rooms which to-day could be kept comfortable by one or two fair-sized radiators.



(The Skin)

THE OPEN FIRE

Finally, during the last quarter of the last century, we returned to the ways of the Romans and once more learned how to keep our houses warm with the help of steam and hot air.

How long the present method of protecting our supplementary skin with the help of furnaces will last, I don't know, but probably not for very many more years.

The modern way of heating rooms by means of electricity is much simpler and much less cumbersome than the present system, which presupposes the existence of a more or less complicated hot-air apparatus in the basement and calls for a horde of janitors and truck drivers.

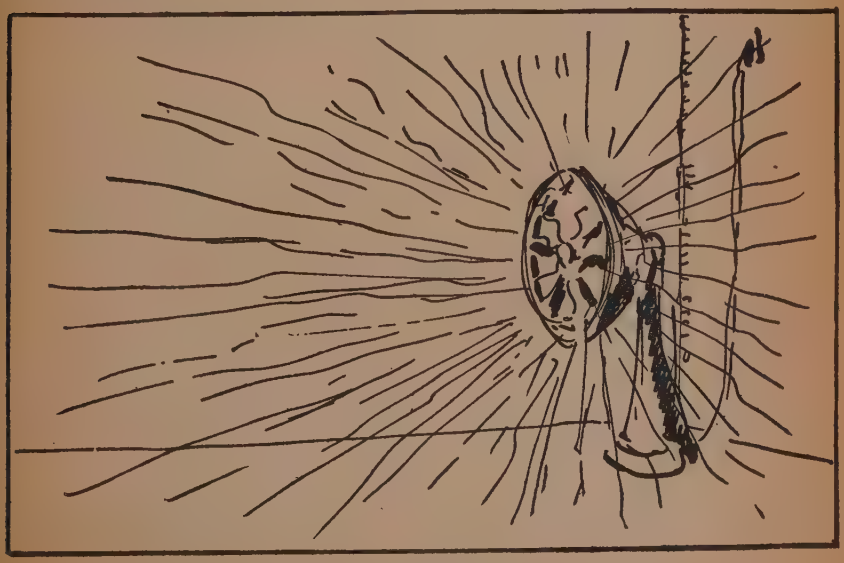
At present the problem is merely a matter of cost. As soon

as we shall have invented a way to make electricity a great deal more plentiful and a great deal less expensive than it is to-day, we shall be able to do away with the coal man and the furnace man and the snorting oil heater and the smelly oil stove and the unsafe gas stove. Thereafter the mere turning of a switch will keep our houses and churches and our public buildings at an even temperature, both summer and winter.

. . . . . .

But before I finish this chapter, I must say a few words about another invention which is intimately connected with the business of keeping warm. I mean the holy art of making fire.

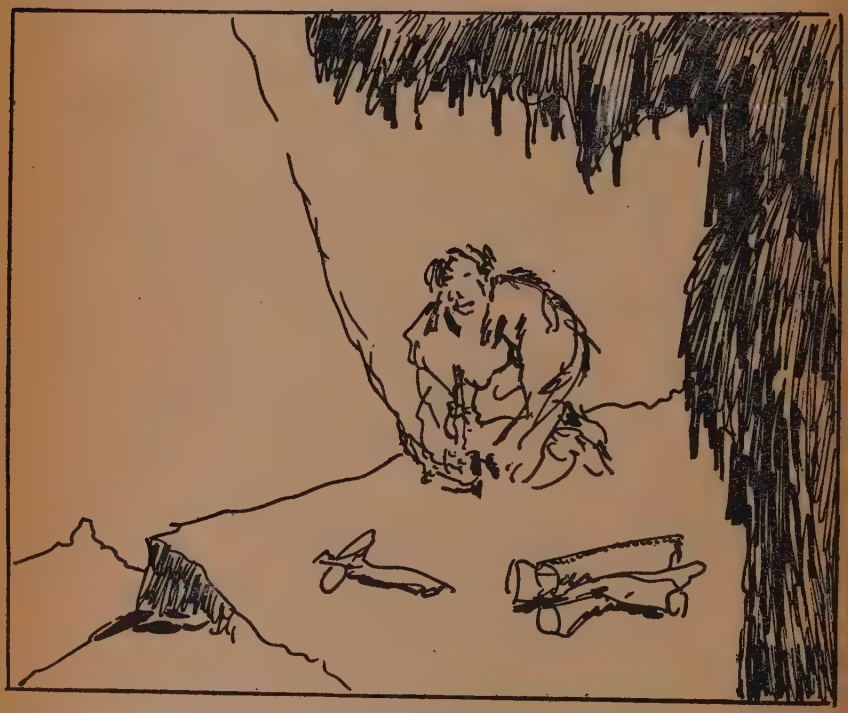
The first fires which man used to warm himself were undoubtedly stolen from a tree which had been hit by lightning. But forest fires do not last forever. And they rarely occur in the middle of the winter, when the demand for protection is at its highest.



(The Skin)

THE ELECTRIC GRATE

Then some bright genius (all honor to his memory! he probably was a priest entrusted with the sacred fire upon which the lives of the community depended) discovered that friction would cause heat. It must have happened very long ago, for when man at last appears upon the historical stage, he already knew how to make fire by means of rotating a stick rapidly through a narrow groove cut into a second piece of wood.



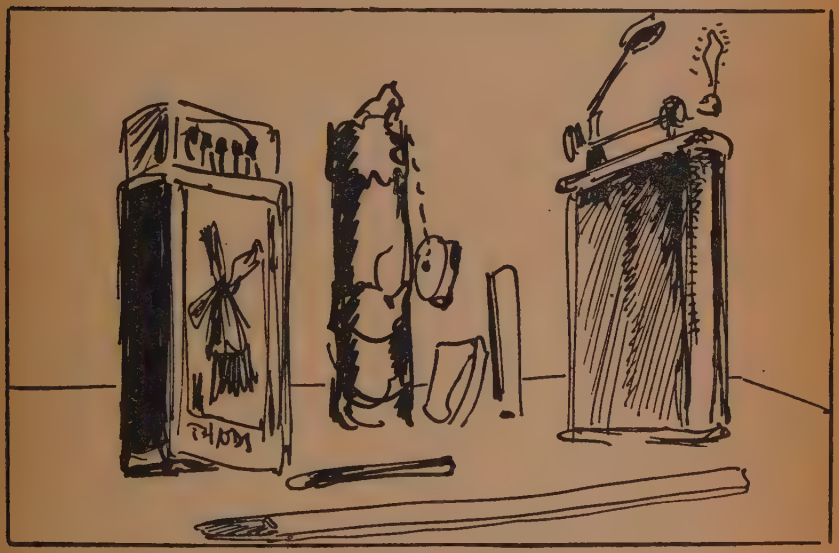
(The Skin)

THE HOLY ART OF MAKING FIRE

A little later, when people commenced to manufacture stone implements, they noticed that when two stones were violently hit together, they produced sparks which could be caught quite easily by a handful of dry moss, which would then start a small conflagration.

This humble instrument, consisting of a fire-stone and a piece of metal, has had a long life. It has been adapted for all sorts of purposes. It gave us the flintlock gun, and finally it gave us our matches.

For the tinder-box, with which our grandpapas lighted their pipes, was a complicated affair and not at all handy when one was obliged to make a fire in a hurry. It was necessary to in-



(The Skin)

FROM FLINT TO CIGARETTE-LIGHTER

vent something a little more practical, and in every town of the old and the new world people were puttering with chemical substances that should do the job of the cumbersome tinder-box.

During the latter half of the seventeenth century, the first varieties of "Lucifers," or light-bearers, were actually invented. They consisted of small bits of phosphorus which were struck with a stone until they ignited scraps of wood which had been soaked with sulphur and which were then used to light the stove. They

were, however, very smelly and rather dangerous and so they never became popular.

But in the year 1827 an English druggist by the name of John Walker invented a "friction match" which would work without setting the house on fire. He called them "congreves" in honor of Sir William Congreve, the man who during the Napoleonic wars had gained great popularity as the father of the famous "war rockets" and who was a pioneer in the general field of fireworks.

Twenty years later a Swede by the name of Lundström, from Jönköping, found a way of reducing the size of the friction matches until they became the "pocket matches"—those little bits of red wood with yellow heads with which we have been familiar all our lives.

Conservative people of course fought the innovation with bitter violence, among other things upon the rather curious ground that the matches would facilitate the labors of second-story men. But in the end, the matches won out and they remained triumphant until the Great War, when the prehistoric tinder-and-flint (in a new and handy combination) was once more revived for the benefit of our cigarette-smoking heroes.

A curious turn of the far-famed wheel of progress.

And an indirect compliment to our long-forgotten forefathers.

CHAPTER III

The Taming Hand

THE human hand is really an ordinary fore-paw, such as any quadruped has, which by developing a so-called "opposable" thumb has made it possible for the creatures possessed of such an instrument of prehension, to do a number of things which other animals not provided with similar "prehensile terminations" are obliged to perform with the help of their claws and their beaks or their teeth.

If this learned sentence does not make it quite clear to you what I am trying to say, just watch your cat or your dog the next time he is struggling with a bone. He seems to feel that his paws may be of some service to him. After he has used his mouth and his nose to grasp and push whatever he wants to move to another corner of the garden, you will notice how in a helpless sort of fashion he attempts to bring his fore-paws into action.

But alas! he has no thumb.

The cat and dog can use their fore-paws for the purpose of holding a bone down while they tear at it with their teeth. They can dig a hole with their fore-feet in which they can afterwards bury their treasure. But they can never get beyond a few clumsy motions, for although they have a "thumb" it is not "opposed" to the four fingers and as a result they are unable to

grasp or to hold an object and can submit it only to a few very simple operations, all of which have to do with the business of satisfying the appetite.

The hand, therefore, is the most important natural tool which man has acquired, and it was through the million-fold multiplication and extension of its power that he was able to make himself the undisputed master of the world.

But here we meet with one of those difficulties of which this book is so full. How and when and why was man able to realize the possibilities of his fore-paws while his cousin the ape (who certainly was just as intelligent in his own way) never learned to reënforce the radius of activity of any one of his four prehensile hands?

Take the question of using a stone for the purpose of increasing the hitting power of the hand. You will say, "That idea was so simple that it must have been self-evident." But nothing in this world is quite so simple as to be self-evident. Some one has to think of it first—try it out—experiment with it until he is blue in the face and half dead from exhaustion or has succumbed under the sneers of his neighbors.

And for thousands of years man simply grabbed at his living food with his bare hands, held his prey with his bare hands, tore little beasts and birds apart with his bare hands and never for a moment thought that it might be possible to do otherwise.

Until one individual at last had the courage to say: "This can be done much better and more simply," reënforced the striking power of his hand with a stick or a stone, and gave us our first hammer.

That is as far as our information goes. Whether that first hammer was of wood or of granite, we do not know and we shall never be able to find out, for wood is a very perishable commodity, while stones will last forever unless they are crushed to bits by a twenty-ton truck or a high explosive shell.

The stones, therefore, are the sole witnesses to proclaim the patience and the intelligence of the people who were the true pioneers of the human race, but the wood is gone and tells no tales.

Of course the layman who visits a museum of prehistoric history is not very deeply impressed. The collection of prehistoric

(The Hand)

STICK AND STONE

tools which is spread out before his slightly bewildered gaze looks for all the world like the pebbles his youngest son is apt to bring in from the roadside.

To the expert, on the other hand, these early hammers and axes and saws are quite as important and as interesting as an exhibition of motor cars from the earliest one-lunged flivver to the latest Rolls-Royce. For they represent quite as much hard work on the part of a vast number of people as the historical models of modern internal-combustion machines.

When man first discovered that he could multiply the

(The Hand)

THE STONES TAKE SHAPE

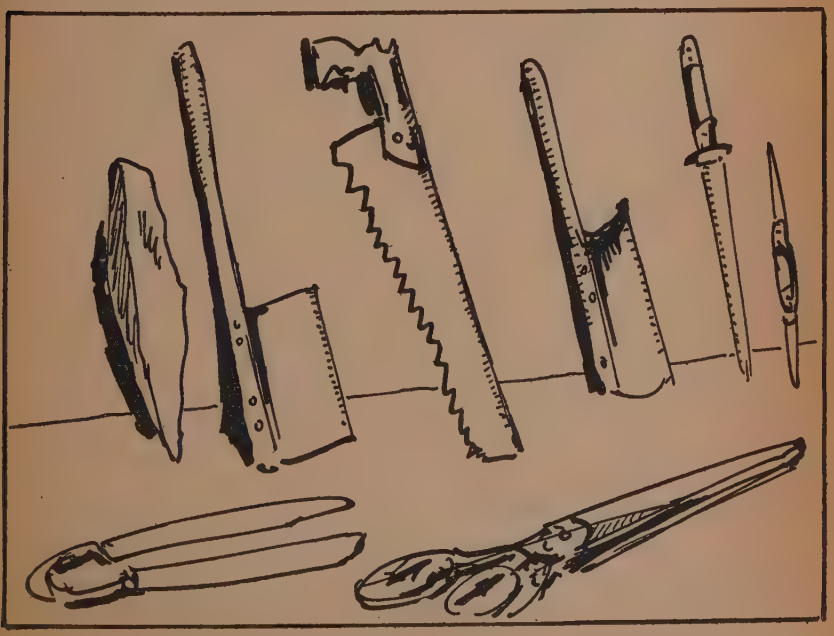
strength of his hand by means of a stone, any stone would do; that is to say, any stone small enough to be grasped firmly by the five fingers of the hand, yet not too small to be effective when used as the means of crushing a nut or a skull or a bone filled with that great antediluvian delicacy, marrow.

Gradually he learned that by chipping and flattening little bits off the sides he could turn his hammer into something that would cut as well as crush. Then began the search for suitable sorts of stone that would chip without breaking. At last they were found. Then some one discovered that by rubbing the sides of his hammer against other and harder pieces of stone, the edges could be polished and then the hammer became a knife.

A few centuries later, when people had also learned that small strips of the dried skin of a dead animal could be used for

the purpose of tying things together, some one fastened his stone knife to a wooden handle and gave us the battle ax, an infinitely more effective weapon than the original "fist-hammer" and a much more dangerous implement of war.

As for the smaller bits of stone with sharpened edges, they were the direct ancestors of our modern knives, our pocket knives and our saws. The saw, which is a most cunningly devised implement for increasing the tearing power of the bare hand, finally gave up its oblong shape, became a round disc and developed into that whining circular contrivance which tears through logs as if they were so much butter and which goes after iron and steel as unconcernedly as if those materials were tissue paper. A hammer is no doubt a very useful tool, but our whole modern industrial development would have been impossible without the augmented hand known as the saw.



(The Hand)

THE STONES BEGIN TO TEAR

As for another little grandchild of the flint-knife, our scissors, it is of much more recent origin, for despite its apparent simplicity, it is really rather complicated.

The Egyptian mummy-makers who possessed elaborate instrument chests seem to have done without scissors entirely. Later on, the Greeks and the Romans devised a sort of shears with which they clipped the hedges of their gardens and with which they finally sheared their sheep, whose wool thus far had been plucked from the backs of the unfortunate animals. Out of these Roman shears our modern scissors developed, and they are really a couple of knives with loops instead of handles and held together by a small pivot, as you may see for yourself the next time your hand needs some assistance in tearing up a piece of cardboard.

So far, so good. But the story of man's ingenuity in multiplying the strength of his organs is, alas, not only a chronicle of progress.

The Gods who rule this universe undoubtedly gave us the faculty to distinguish clearly between that which is good and that which is evil. But they decided to let us make our own choice and therefore bestowed upon us that irritating spiritual quality which our grandparents, who took a more serious interest in theological problems than we do, called the "free will." It is the terrible "free will" which permits us to use our inventive power for evil quite as often as for good. And, being a strange mixture of contradictions, the average human being is just as apt to employ his brains for the purpose of devising a bomb as a ballad.

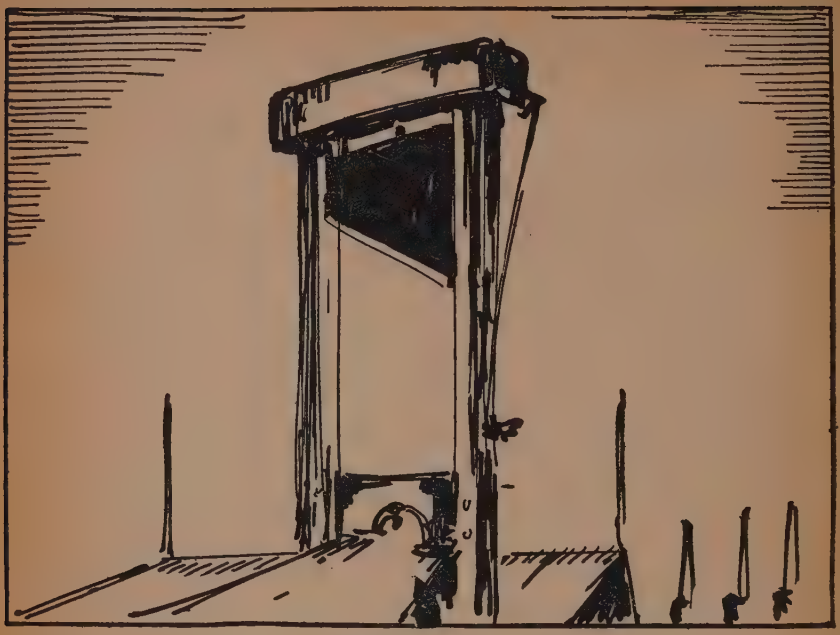
The knife which was born out of the most primitive of all necessities, the need of keeping alive in the midst of thousands of hostile forces, was immediately afterwards turned into an instrument of unnecessary violence. In the form of swords, sabers, bayonets, lance-points, arrow-heads, cutlasses, daggers, yata-

ghans, claymores and scimitars it has made a triumphant procession around the world, slaying and hacking and cutting people to pieces for no other reason than that they possessed something which some one else wanted for himself or that they held certain ideas which others did not happen to share.

All of which is a great pity, but remember that human inventions are soulless creatures like the multiplication signs of our table of multiplication. Those little crosses do not care what they multiply. They would just as soon multiply —100,000 with —10,000 as +100,000 with +10,000. It happens to be their business to multiply things with each other. Beyond that they do not act and they do not care. They will multiply anything that is given to them and care not whether the outcome spells ruin or success.

It is very easy to talk about progress as if it were something automatic, something that was forever leading from worse to better, from low to high, from poor to rich. I wish that were true. But the path of progress is a steep and winding path that takes strange turns, and the "reënforced hand" which has done so much to hack out that ancient highroad gave us not only the scissors with which the physician saves human life but also the grewsome contraption with which good Dr. Guillotin snuffed out the lives of his compatriots in such an expeditious and economical fashion.

This chapter begins to sound like a tract. I am sorry, but at the same time it is well to remember these things at the present moment, when a sudden deluge of mechanical perfections has given many people a dangerous feeling of ease and reassurance about the future of the human race. If all goes well with us, we may eventually amount to a great deal. But please do not overlook the fact that for every dollar the average nation spends upon its schools, it spends a hundred upon its battleships. And having planted that little mustard seed of wholesome



(The Hand)

THE GUILLOTINE

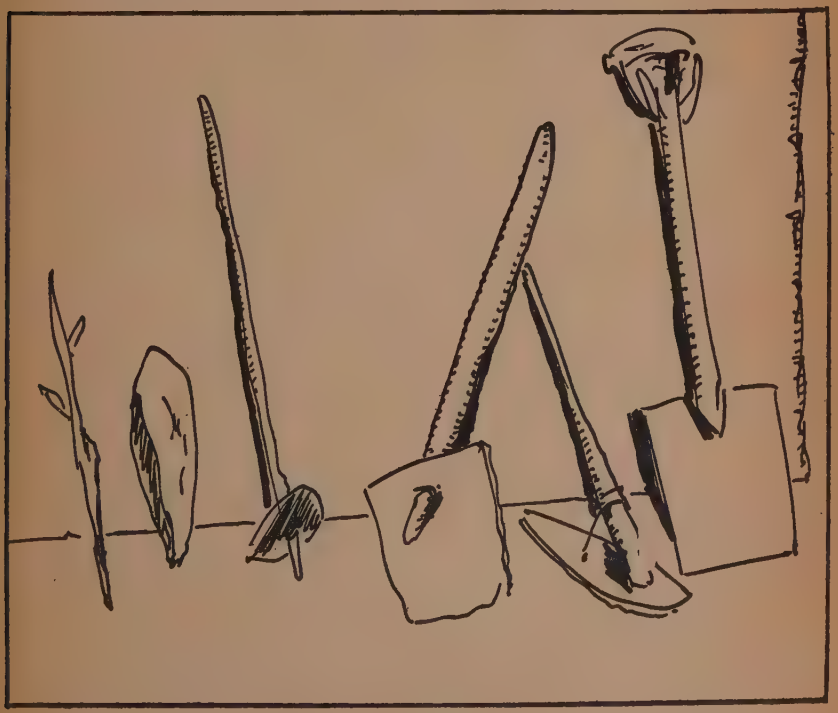
doubt and worry in your mind, I shall now proceed to the next invention connected with the human hand, which is nothing more nor less than the agricultural implement called a spade.

The inventor of the spade probably was a woman. In the earliest agricultural communities of which we possess any record at all, men did not demean themselves with work in the fields, they left that to their wives and to their daughters and to their donkeys. I have no doubt that one fine day some poor, bedraggled female grew tired of breaking her nails while pulverizing the soil with her hands and picked up a stick or a stone and let it do the work of her fingers.

As the human race learned the use of bronze and iron and copper and steel, it was natural that those metals should be used to reënforce the point of the stick, which was very breakable,

and then by the gradual broadening and flattening of these pieces of metal we finally got a rudimentary form of a spade.

Of the hardships of these earliest workers in the picturesque but heart- and back-breaking realms of agriculture, only those who have seen the peasants of Egypt or Russia or northern Africa, hitched to a plow, can get a clear idea. An Arab plow (which is nothing but a slightly multiplied spade) looks very interesting in a museum. But the modern steam plow, doing the work of a thousand hands at the same time, is a much more agreeable sight to modern eyes, which are willing to forego a certain amount of romanticism if they are no longer forced to watch their fellow creatures being used as beasts of burden.

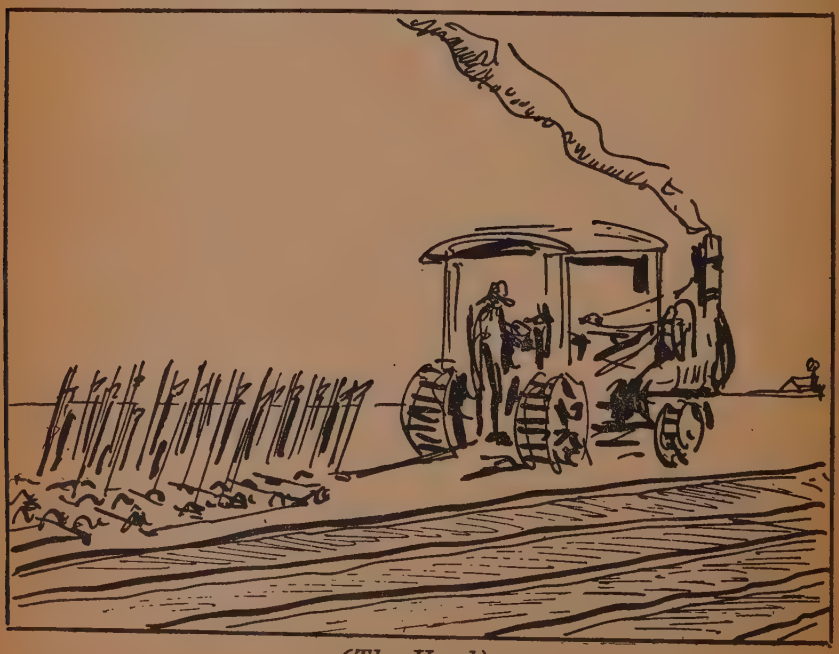


(The Hand)

From Fingers to Spades.

Perhaps the term "modern eyes" is not quite correct. "Human eyes" would be a better expression, for the more intelligent and "humane" among men have always regarded unnecessary toil as an offensive nuisance. All through the ages we hear of inventions that were meant to relieve the workers of part of their burdens. Often the workers themselves had been so cowed by centuries of abuse that they fought those innovations, as birds born in captivity will struggle with those who are trying to set them free. Thus it could happen that those improvements which would have done away with endless hours of stupid drudgery remained mere blueprints in the desk of some forgotten scientific genius.

The fertile brain of the great Leonardo of the village of Vinci was an example in case. Leonardo was forever occupying himself with problems of such a sort, and the multiple hand



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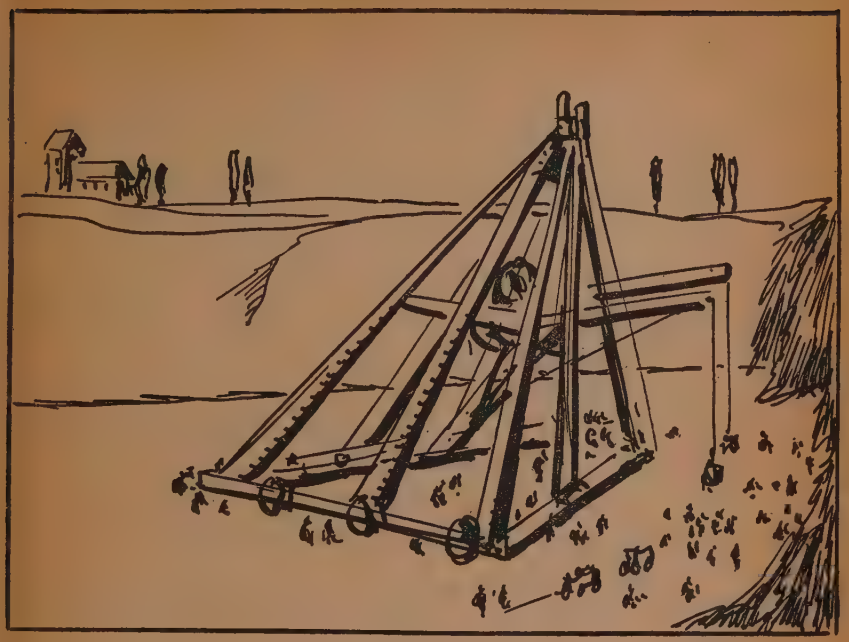
THE STEAM PLOW



(The Hand)

THE DIGGING MACHINE

which he proposed for the purpose of digging canals in the valley of the Po was never put into practice. It would undoubtedly have thrown a few people out of employment, but it would have made the lives of thousands of others infinitely more pleasant. But even those who were to be benefited could not see it that way and Leonardo was obliged to score another failure. He might have been more successful with his multiplied hand if he had tried to promote his machine in the Low Countries when the merchants began to clamor for a hand that would work beneath the surface of the water and commenced to experiment with dredges. But he lived in Italy and there the problem had never been a very serious one. The ships of ancient times had had so little depth that they could be parked almost anywhere. But during the latter half of the Middle

Ages, especially along the shores of the North Sea, where rivers and tides played havoc with the harbors, it was necessary to think of some method by which the superfluous sand could be scooped up from the bottom of the rivers and bays. Dutch and English engineers then perfected the land dredge of their Italian

(The Hand)
THE DREDGE

colleague and provided floating, flat-bottomed barges with spades that could dig under water. At present 90 per cent of all international commerce would come to an immediate standstill if those iron fingers which scrape the bottoms of our ports (sometimes at a depth of sixty feet) should go on strike for a single week.

The dredge, however, could do only one sort of job underneath the waters, and with the rapidly increasing importance of foreign trade, it was necessary to think of a method by which one could remove an entire carpenter and blacksmith shop to the river bed. But carpenter shops and blacksmith shops de-

(The Hand)

THE DIVER AT WORK

pend for their successful operation upon the presence of carpenters and blacksmiths. And both carpenters and blacksmiths, if they are to do any work at all, need a regular supply of fresh air.

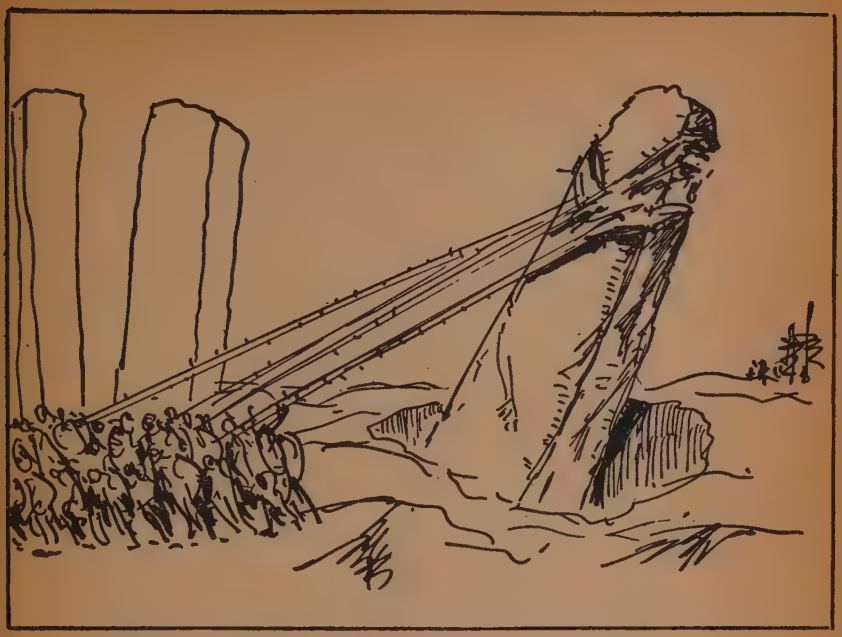
It was possible, of course, for a good swimmer to dive for a couple of oysters (as the Greeks did during the siege of Troy) and to remain beneath the surface for 60 or 80 seconds. But

when one was obliged to repair a hole in a ship or lift a heavy case of gold that had gone overboard during a storm, these short dips were of no earthly use. The lungs which served the hand had to be provided with an instrument that should guarantee them an uninterrupted flow of fresh air.

The first efforts made along that line consisted of a copper pipe which connected the mouth of the diver with the surface of the water. This, however, was only practical in shallow water. Gradually the copper tube was discarded for a leather pipe, the mouth of which remained afloat on the surface with the help of a pig's bladder. This leather pipe was the only diving apparatus which people could use for more than 2,000 years. At the end of the seventeenth century, however, an Italian

(The Hand)

THE LEVER



(The Hand)

THE ROPE

had the bright idea of forcing air through this leather pipe with the help of a couple of ordinary bellows. The first experiments were successful. Ever since the under-water hand or diving machine has been steadily improved until to-day we are able to repair ships or fish for sponges at a depth of more than 180 feet, a terrific distance, as all those will appreciate who have ever tried to pick up a stone from the bottom of a pool.

But I am running a little ahead of my schedule and perhaps I had better first tell you of some other very primitive tools which were invented tens of thousands of years ago and also bore a tremendous influence upon the further development of human history.

For example, there was the lever. A lever is one of those simple contrivances of which people are apt to say that they are as old as the hills. It certainly has had more to do with

changing the aspect of our landscape than anything else ever devised by the human hand. As a matter of fact, it is a very simple instrument, but without it neither the pyramids nor the dolmens nor any of the other prehistoric temples and graves con-

(The Hand)

PAINFULLY HAULING A HEAVY STONE

sisting of gigantic bowlders and pieces of granite could possibly have been constructed. For the lever represented the infinite multiplication of the strength of the combined hand and arm and in its modified modern form it will lift up anything from a locomotive to a house and will do the work of a thousand hands at a cost of a few dollars.

Closely connected with the invention of the lever was the discovery that one could pull a much heavier load than one could

carry and that all one needed for the latter purpose was a greatly elongated hand, or as we say to-day, a "rope."

Whether the first rope was of hemp or of skin, I do not know. But as cotton and hemp were not introduced into the valley of the Nile and into Mesopotamia until a comparatively late date, the lariat made out of leather must be the older of the two. Even with the help of cords made out of the twisted fiber, the business

(The Hand)
THE PULLEY

of hoisting heavy materials to the top of a scaffold was a very painful operation for the hundreds of slaves that were doing the pulling. This hardship, however, was greatly lessened when the Babylonians, after years of experimenting (we can follow these experiments on their pictures) finally provided the human hand with a pulley (or block) which made it possible for one or two men to do as much as a hundred had done before.

The Greeks seem to have done most of their building with the

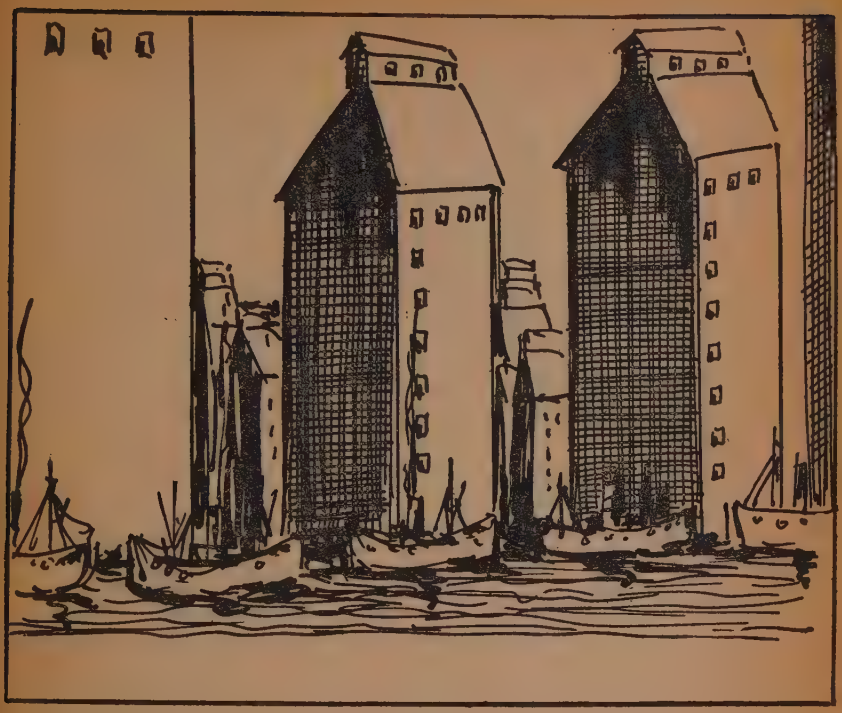
simple assistance of levers and ropes and inclined planes, but the Romans, the architects of the ancient world, with their passion for roads and fortresses and bridges and harbor-works and aqueducts, greatly improved the pulley and gave it its present form. They even wrote books about the best ways of making blocks and trees and they bestowed upon the people of the Middle Ages a most welcome and unexpected inheritance. For without an endless variety of pulleys, the large sailing vessels of the fifteenth century could never have been handled, and without those sailing vessels, the nations of Europe would have been doomed to remain forever marooned on their little continent.

. . . . . .

And now we have got to speak of another quality of the human hand which in its multiplied form plays a most important rôle in modern society.

(The Hand)

THE FIRST CUP



(The Hand)

THE GRAIN ELEVATORS

For the hand can do a great many things besides holding and lifting and pulling and striking. It can also serve as a container, as you will know if you have ever drunk water from a brook by means of your hand transformed into a cup. In a pinch, the two hands, with the palms held together, can even be used as a receptacle for the purpose of carrying quite a lot of nuts or berries. But of course the hands held together that way can only perform temporary services. After a few minutes they tire and insist upon resuming their normal position by the side of the body.

People knew that 50,000 years ago as well as we do to-day. And they looked for a more permanent form of container in

(The Hand)

THE BASKETS

which they could store grain and if possible water. They found this in the tops of the skulls of their dead enemies. That part of the skull closely resembled two hands being held together and they lay about in enormous profusion, for the idea of burying the dead is of comparatively recent origin. A skull was a grim sort of vegetable dish but people who lived the way cave-dwellers lived did not mind such trifles. And the human skull became so popular that it entered into the religion of the people of the North. Their gods invariably used the skulls of their rivals as drinking-mugs and the faithful were promised that they should enjoy the same luxury if they would kindly take the trouble to die in battle.

It would be easy to jump directly from the skull to the grain-elevators, for the one as well as the other is merely a substitute

for the hollow hand. But ere man began to build warehouses and water-tanks and storehouses, the hand-as-container had to go through a great many intermediary forms of development, some of which were extraordinarily interesting.

Unless we are entirely mistaken, the first artificial substitute for the skull (or the hand, as you will begin to say after reading this book) was the basket. The art of basket-weaving is one of the oldest of the crafts. Willow trees grew in abundance near the shores of those lakes and rivers around which the people of the Stone Age liked to live, and rushes were to be found almost everywhere. The basket gained such great honor in primitive society that the pattern of neatly entwined twigs and reeds sur-

(The Hand)

THE CLAY-COVERED BASKET

vived far into the Middle Ages and was a favorite model for the stone cutters who carved the pillars of the great cathedrals.

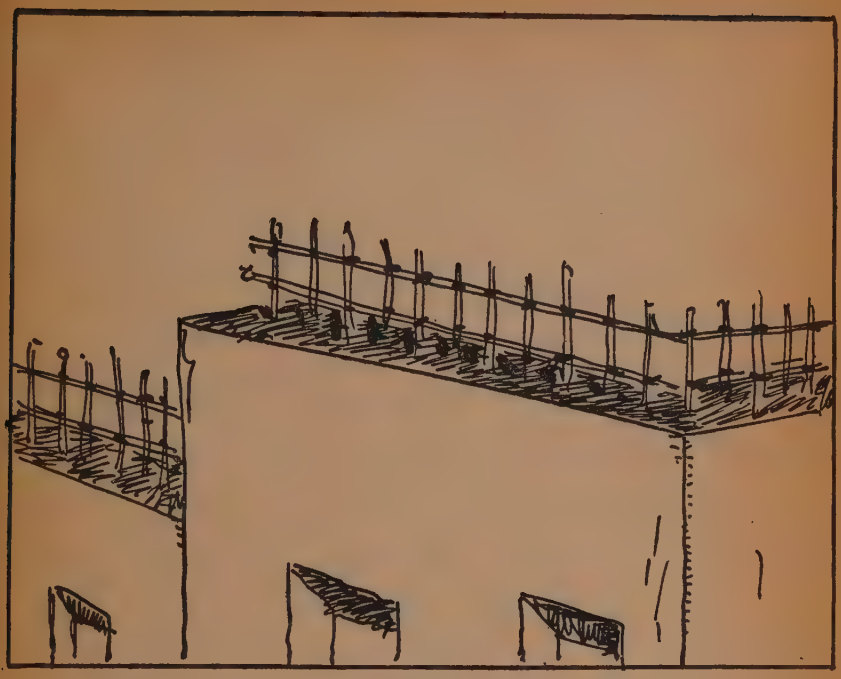
But of course anything made of wood was perishable and we have only circumstantial evidence about the skill of the antediluvian basket-maker. He seems, however, to have been regarded as a very important member of early society, and this respect increased when he learned to cover his wickerwork with an outer coating of leather or clay. For he then gave his people a number of useful inventions.

There was the boat made out of a skeleton of basketry covered with the skins of animals. Next, the light and portable shield, which gained enormous popularity when soldiers began to wander all over the face of the earth.

The clay-covering process was responsible for the house made of a wicker framework covered with wet earth, a method which was revived a few years ago when architects began to build houses made out of steel frames and concrete. But the most interesting development of the basketry craft and the most useful from the point of view of human civilization occurred when a manufacturer of receptacles brought out a new and improved form of non-porous bowl which consisted of an outer shell of basketry covered on the inside with a thick layer of clay.

The new invention was by no means perfect. The clay remained soft and smeary for a long time. All the same, it was much better than anything that had been on the market before and found a ready sale.

The next step, which was to turn the basket into the earthen jar, was probably due to an accident. But accidents have always played a very important rôle in the history of invention and deserve a statue of their own in the technological Hall of Fame. Perhaps a basket was dropped into a fire through negligence, or a cave was burned out, or a marauding expedition started a conflagration that destroyed a whole village. Anyway, when the



(The Hand)

THE CONCRETE WALL

rubbish was cleaned up and the fire was extinguished, it was seen that the protecting cover of twigs and rushes had been consumed by the flames, but that the clay interior not only had remained behind but had been changed into a substance that was as hard as stone.

That was the beginning of pottery.

Gradually the basket was discarded entirely (except for solid substances like olives or melons or potatoes or grain) and pieces of baked clay, resembling in their general appearance the hollow of the human hand, were substituted for the old-fashioned container that had been woven out of grass or twigs.

In the beginning the clay necessary for this purpose was taken from the river bed and rudely fashioned into a hollow

shape with the assistance of the fingers. It was a slow and unsatisfactory method but there was no other until an Egyptian invented the potter's wheel. In the beginning, this wheel was set in motion with the left hand while the potter worked his material with the right, but gradually the wheel was brought lower and

(The Hand)

THE POTTER'S WHEEL

lower until it reached the floor and became a disc which was set spinning with the help of the feet. At the same time great improvement was made in the art of baking the finished product.

The Chinese apparently were the first to conceive the idea of using a kiln for this purpose. A kiln was a sort of oven which could be tightly closed on all sides, while the contents were exposed to the even temperature of a wood fire; and by way of

Babylonia (which forty centuries ago acted as the intermediary between Asia and Europe) the new method soon spread throughout the West. Both the Greeks and the Romans became expert potters and performed new marvels in the field of ceramics through the introduction of a perfected form of glazing which gave their vases and even their common household pots and pans a nice smooth glossy surface and which was first used by the Egyptians, who, in turn, had learned the trick from the Phœnicians.

This is the first time I have had a chance to mention the Phœnicians. They were the middle-men of the ancient world, the common carriers of the Mediterranean. They made nothing but sold everything. Literature and art did not interest them and they contributed very little to the sum total of those technical improvements which the people of the classical world bestowed upon us. Curiously enough, those outspoken materialists, who made enormous fortunes out of the slave trade and who were hated wherever they showed themselves for their merciless harshness in striking a bargain, were responsible for two of the most important inventions of which we have any record.

One of these, glass, had to do with the preservation of liquids; the other, the alphabet, with the preservation of ideas.

There is even to-day a serious difference of opinion as to who made the first glass. According to the Romans and the Greeks, it was a Phœnician merchant who was traveling through the Syrian desert and who rested his cooking pots, absolutely through chance, on a few chunks of natron. In the morning he then noticed that the sand of the desert and the natron had melted into small pieces of a transparent substance which seemed to offer great possibilities as substitutes for beads and pearls.

Phœnicia and Egypt were near neighbors. A modern train connects the two countries quite easily within less than ten hours. Soon the jewelers of Memphis and Thebes were selling glass

(The Hand)

THE INVENTION OF GLASS

necklaces to their customers. After they had been playing around with this new material for a little while, they found that it could be molded into all sorts of shapes by exposing it to the heat of a medium-sized fire. There are one or two Egyptian pictures of a very old date which seem to prove that the Egyptians had also learned to use the blow-pipe and therefore could make bottles and vases. The pictures, however, are confusing and it is doubtful whether they represent glass-makers or members of another guild.

The Romans, however, were past masters in the art of glass-blowing, and during the days of their empire glass became a serious rival of pottery as a substitute for the hand and every

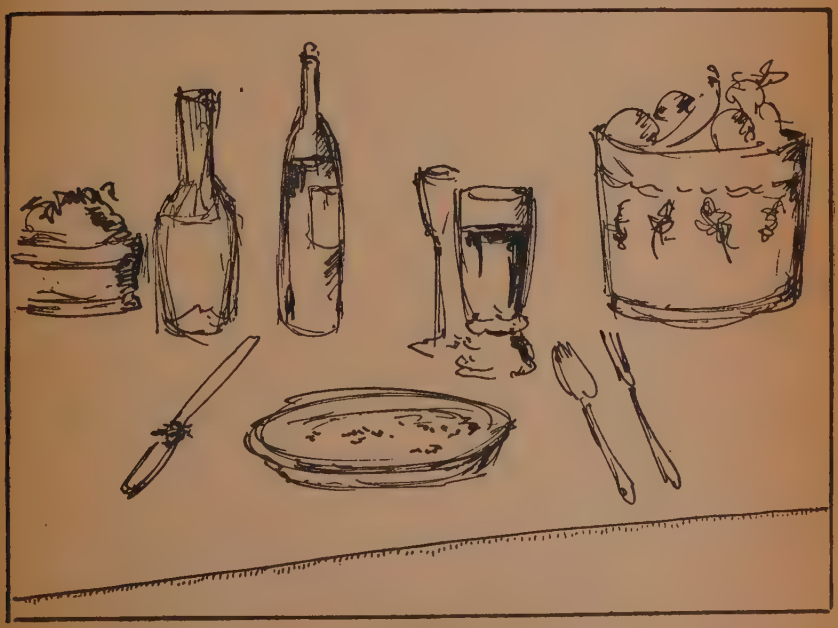
form and variety of container which formerly had been made of twigs or clay was now blown out of glass.

The hand had gained in strength, but it was also becoming brittle.

. . . . . .

Accident, as I just said, has played an important rôle in the history of inventions. But snobbery also ought to receive honorable mention as an incentive to making ever better and better implements of daily use.

In the beginning ordinary pieces of pottery were good enough for the better-class Roman families. But when the kilns of Britain and the Rhine valley began to flood the Roman market with cheap earthenware, the patricians felt that they could no longer load their tables with mugs and dishes that were to be found in every proletarian home. Hence their willingness to pay



(The Hand)

THE DINNER TABLE

generously for rare glass vases and bottles and tankards. Now whenever there is a willingness on the part of certain members of society to expend vast sums upon some particular article of luxury there invariably arises a class of artisans who are not only eager but also capable of fulfilling that want.

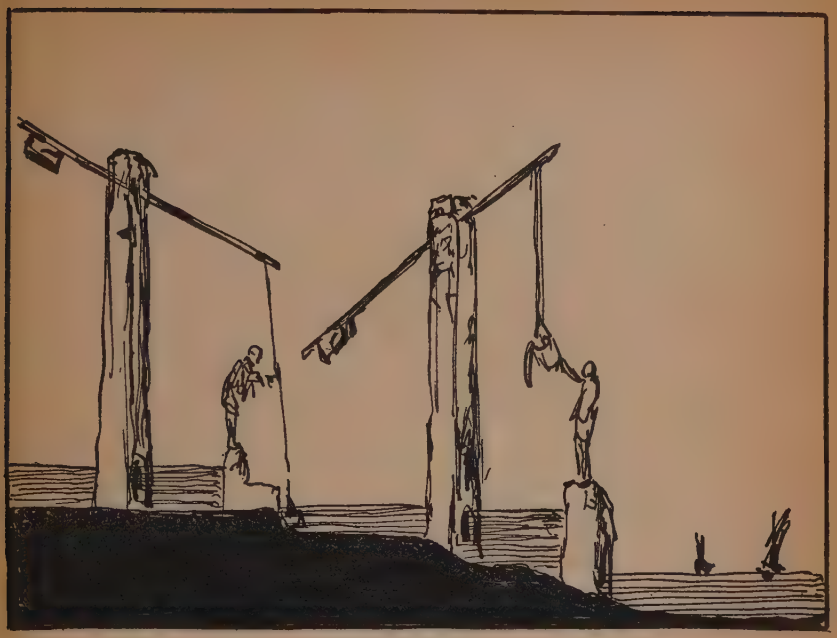
The Romans were bad painters and indifferent writers and sculptors, but they were past masters at the business of living. Among other things, they were the first to recognize that meals should be solemn occasions rather than catch-as-catch-can races for the fattest chunks of mutton and the greasiest pieces of marrow-bone. They did not quite succeed in giving us that highly useful substitute for the human fingers known as the fork (which is of very recent date) but they taught the world how to set a table with decency and grace, which is the first step in the right direction of changing the unpleasant process of feeding into the pleasant custom of dining.

. . . . . .

Once the artificial container had been invented, a large number of things became possible which had been completely out of the question as long as man had been obliged to do everything with the hollow of his hand.

Among other things, vast tracts of land that lay above the surface of the rivers and the lakes could now be made fertile with the help of a simple form of irrigation machinery, which consisted of levers and pails and ropes. As a result of this, a much larger number of people could be fed than before and the population of several countries doubled and trebled within a few centuries.

But in another way the hand, acting as a conveyor, contributed seriously to the general happiness of the human race. I refer to aqueducts and water-works. The ancients were not very good at medicine. Their physicians knew a few elementary



(The Hand)

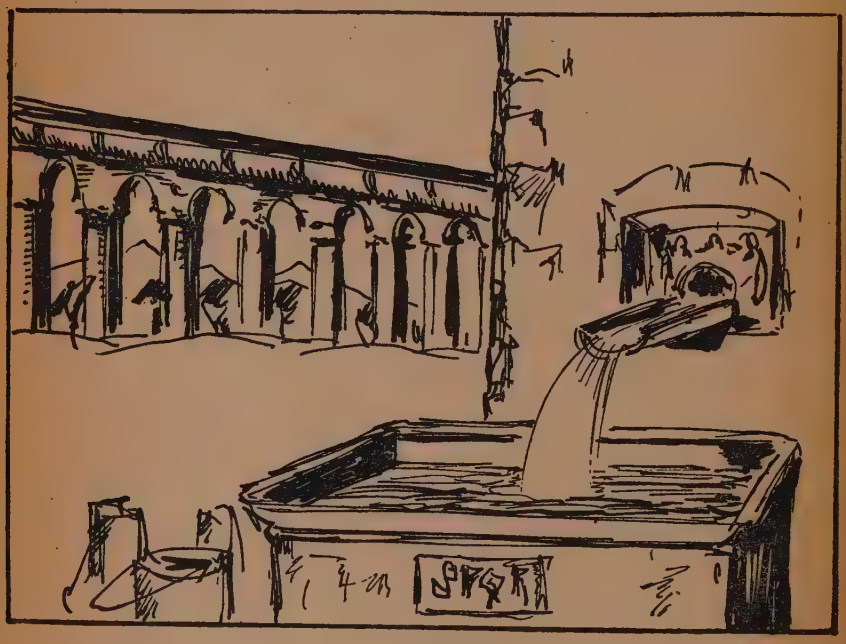
IRRIGATING THE LAND

facts about physiology, but were completely ignorant about many things which to-day are taught in grammar-school. They realized, however, that wherever there are a large number of people together, it is absolutely necessary for them to have decent drinking water.

Brooks and rivers are in the habit of purifying themselves of all microbial iniquities whenever left to themselves and given a chance to expose their contents to the rays of the sun. But when towns grew larger and larger and their slums were filled with a larger and larger number of paupers, the near-by rivers were speedily transformed into fertile cesspools, polluted by myriads of busy little microbes. It would of course have been possible to bring water from the near-by mountains in the hollow of one's hand or in a cup or in a pail, but the system would have

been rather slow and not very effective. And so the hand (in its rôle of container) gradually developed into the aqueduct.

Those who have seen the remnants of the water-works built by the people of the ancient world, who have seen the ruins of their cities full of fountains and well-heads, will realize that the engineers who first thought of this method to provide the



(The Hand)

AQUEDUCT

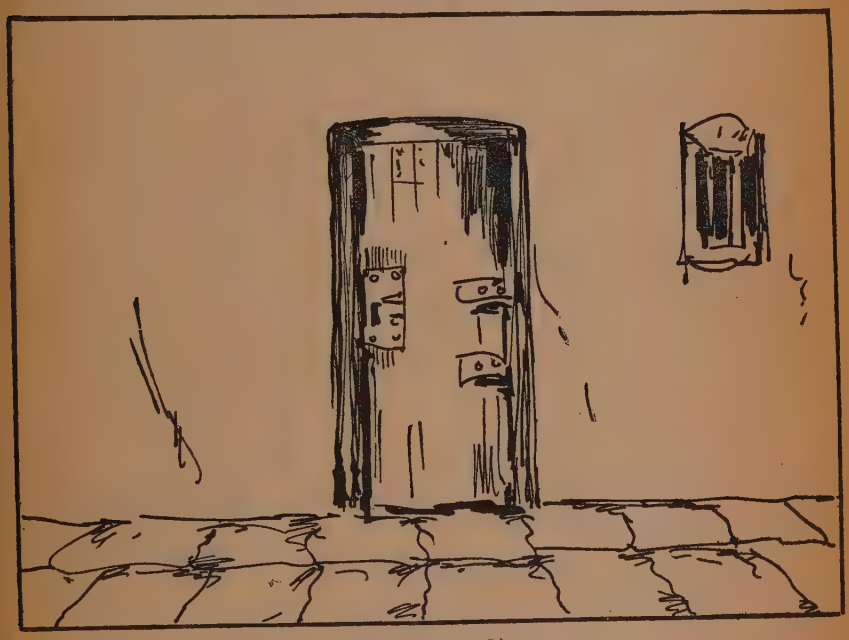
millions with fresh mountain water were among the real benefactors of the human race.

Whereupon we bid farewell to the hand as a "container" to speak of it as an instrument that can grip and hold.

In this quality it appears among us mortals first of all as a lock. For no sooner had man built himself a house than he must needs fill his rooms with a large number of worldly goods which were either meant to contribute to his happiness or expected to

give him the pleasant feeling that his neighbors envied him for his riches.

To protect such belongings against the attentions of his enemies and friends, he was forced to fasten the door that gave entrance to his domain in such a way that while others could not enter, he himself was not forced to remain outside whenever



(The Hand)

THE DOORLOCK

he wanted to come in. That sounds easy but it was quite difficult. A plain bolt would of course do the trick, but it forced the person who had shot the bolt to stay forever inside the house together with the things he had locked up. Then some one devised a way which made it possible for the person on the outside to unfasten the bolt if he had the right sort of iron pin.

Out of this combination of bolt and pin finally grew the modern lock, which although vastly more reliable has not changed

(The Hand)
THE CASTLE

much in its essential qualities from those latches which we see in Egyptian pictures of the thirteenth century before Christ.

All these fasteners, by whatsoever name they were known, were really substitutes for the human hand.

Even those picturesque castles which during the Middle Ages dominated the mountain passes which led from one country to another, and the fortresses which defend our frontiers against foreign aggression, are nothing but bolted doors or, in the terms of this book, are sublimated hands, augmented to the *n*th power, capable of doing on an enormous scale what the lock on our front door does in a more humble fashion.

Which brings me to still another point which I should discuss with particular attention.

. . . . . .

As I have remarked before, the hand has no soul, no conscience, no feeling. It will bestow a benediction at the same time that it draws a stiletto. Since the world has been created in such a way that every living being must destroy some other living being in order to keep alive (whether the victim be a daisy or a cow) it follows that we can't be angry with man for making use of the greatly multiplied power of his hand to obtain a more regular and abundant supply of food.

He did this first of all by replacing the fist of his bare hand by a stone.

Next he sharpened the stone.

Then he turned it into an ax and into a knife and into a harpoon.

With the help of this harpoon, especially during the long

(The Hand)

THE FISHERMAN OF PREHISTORIC DAYS

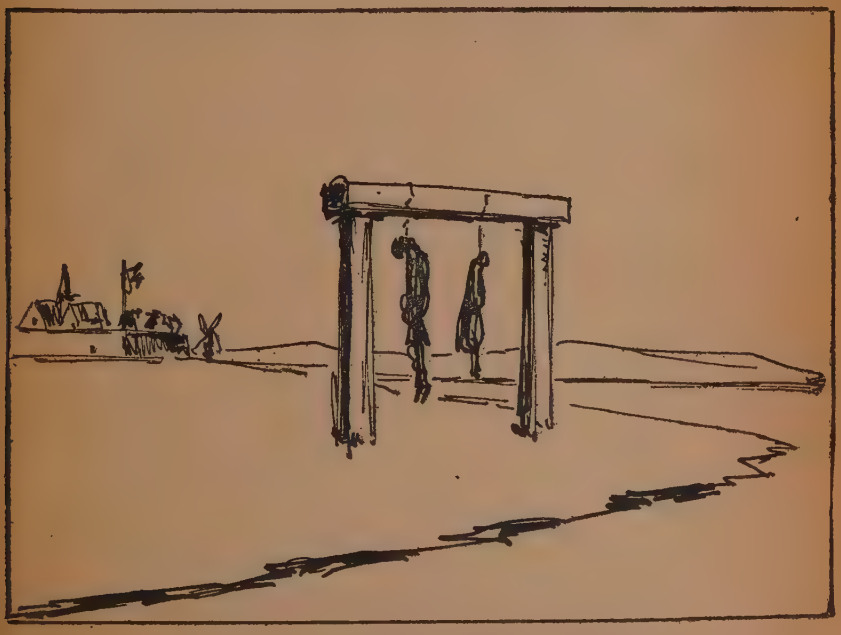
(The Hand)
THE FISHING TRAWLER

periods of cold when he was obliged to struggle morning, noon and night for enough to eat, he accomplished some very remarkable feats. But none of these quite sufficed to satisfy his appetite. Then he figured out that a hand, transformed into a vast ladle, would be able to scoop up infinitely more fish at one and the same moment than the same hand used as a spear. The result was the net which like some sort of vast dredging machine reaches underneath the surface of the water and brings up a thousand fish at a time.

Now that I have mentioned them, fishing boats are perhaps not very pleasant institutions. But what will you? They are necessary. Man must live, and therefore fishes must die. It is regrettable that they must die through slow suffocation, but fortunately they never say much about it, as nature has omitted

to provide them with vocal cords. And besides, man from earliest time on had been accustomed to see others perish through strangulation. He had found it one of the easiest ways to dispose of his enemies or to dispose of those captives of war who happened to be a drug on the slave-market.

Who perfected the throttling power of the hand until it became our highly practical modern gallows is not known. The Egyptians (a docile and peace-loving people, too generally poor to be very generally dishonest and too generally well fed to be very generally envious of their neighbors' possessions) did not know this form of punishment. The Greeks were great fighters but seem to have been deficient as executioners. Besides, they were a people with a fine artistic sense and preferred to let their criminals die agreeably and decently in a comfortable room,



(The Hand)

THE GALLOWS

quaffing a peculiar mixture of wine and poison and holding converse with their friends until the very end. But the Romans, with their respect for "system," found hanging a very efficient method to rid themselves of the unwanted elements of society, while the Middle Ages, with their vast repertory of torturing implements, retained the noose as a mild form of punishment for those who were considered worthy of special consideration. And since we have once touched the subject of man's inhumanity to man, we may as well finish our little chapter on the hand as an instrument of violence right here and now, for the sooner we shall be done with it, the better for our self-respect.

. . . . . .

By this time it will have become clear to you that a battle-ax was really nothing but a greatly improved fist. When the battle-ax was thrown (a form of fighting highly popular in the early days) it became a fist that was doing its work at a distance. But battle-axes and spears and pieces of stone, when propelled merely by the muscles of the arm, did not carry very far. Something better had to be thought out. And because there was a world-wide demand for a method by which one could propel deadly missiles (in other words, hands provided with sharp points and razorlike blades) across a considerable space of ground (a precaution which allowed the thrower himself to remain well out of reach of his enemy's sword) literally hundreds of thousands of people, during tens of thousands of years, devoted all their waking hours to this one subject and finally it was solved by the invention of the sling-shot and the bow and arrow.

The bow and arrow, being infinitely more accurate, survived, while the sling-shot fell into disuse after a very short time. But the bow and arrow grew and grew, both in shape and size and in deadliness, until near the end of the Middle Ages our old friend, Leonardo, bestowed upon his contemporaries the plans for a

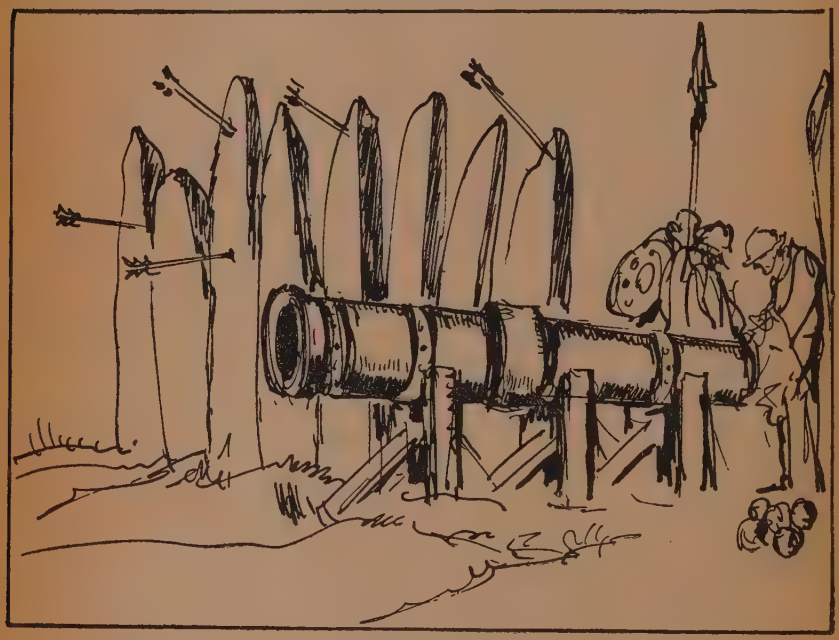
(The Hand)

BOW AND ARROW

stationary bow and arrow which was almost as powerful as a small cannon and which would drive a heavy beam through any form of armor that was then on the market.

But in the realm of war, man has shown himself surprisingly cunning. Every new method of attack is invariably answered by a new mode of defense which makes the former a useless waste of time and energy. As soon as the first stone spear had been invented, some one devised a shield. Then the spear-makers got busy and polished their spear-heads until they would slip smoothly through the ordinary wicker shields. Then the shield-makers got busy and covered their shields with cowhide. Then the spear-makers got busy again, and so on and so forth until the present day when we have the big-armament manufacturers, and the big-gun specialists.

During the fourteenth century, however, it seemed for a moment as if the spear-polishers had definitely outwitted the shield-makers, for a chemical compound consisting of saltpeter, sulphur and charcoal, a disastrous trinity of evil forces which until then had only been used for incendiary purposes, was discovered to be possessed of great explosive possibilities and in connection with a hollow brass pipe it was made to heave large stones across several hundred feet of territory.



(The Hand)

THE STATIONARY GUN

The new invention came a little too late to be of any use to the Crusaders, who otherwise might have succeeded in gaining Palestine for the good cause. But after the middle of the fourteenth century, the new-fangled "gonne-powder" took part in every battle.

The origin of this strange word is uncertain. It has been

suggested that it was the abbreviation of the name Gunnilde, given to one of the hollow brass pipes which were supposed to heave the stone shells at the enemy; and this is quite possible, as those early monsters were all of them called after popular ladies, just as the 42 cm. product of Mrs. Krupp's famous factory was affectionately known as a "Dicke Bertha."

But whatever its name, the noisy blowpipe soon came into its own as the most powerful long-distance fist that had so far

(The Hand)

THE GUN ON WHEELS

been put upon the martial market. It bestowed such enormous advantages upon the quick-moving, fast-shooting infantry, which thus far had been completely at the mercy of the armor-clad cavalry, that the noble knights at once passed drastic laws, declaring the innovation to be "contrary to all principles of civilized warfare" and threatening every man caught handling

(The Hand)
THE CAMOUFLAGED GUN

a mangonel or a serpentine with instant death on the gallows as a common pirate and an enemy of mankind.

This did not greatly help their lordships, for the "gonne" proved such a valuable ally to the long-suffering burghers and peasants that the ungainly creature had come to stay, to the great and everlasting detriment of feudal walls and royal fortresses. It was even given a couple of wheels (thereby becoming a sort of portable hand) and it was made the subject of much constant improvement and tender care.

This arrangement might not be ideal from a spiritual point of view, but its value from a practical angle should not be underestimated. For the inhabitants of the rapidly growing cities were usually much better provided with ready cash than their

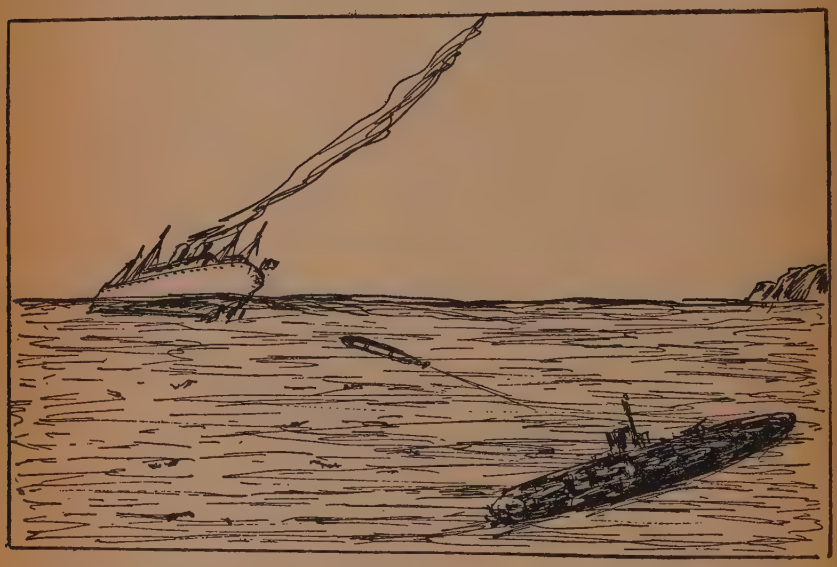
esteemed masters, who dwelled in rustic boredom underneath the leaky roofs of their ancestral castles and therefore the former were able to deprive the latter most efficiently of their leading position in society and hoist themselves into the seats of the mighty. What use thereupon they made of the invention of the legendary Berthold Schwarz (the German monk who appears to have invented the first gun that was of any practical value) is, alas, so well known that I need not repeat it here.

Nor shall I devote much time to that even more complicated form of the hand-at-its-deadliest, the army. Most of our history books are full of the exploits of the gentlemen who specialized in this sort of "handiwork," and by some queer trick of the mind those who have "handled" millions of their fellow men with a little more disregard for the sacredness of human life than their opponents are the men who have gained the greatest amount of fame and have acquired the largest number of statues.

(The Hand)

THE ARMY

I have already described the hand as a crushing instrument. The inventor of the stone hammer undoubtedly was fond of nuts and lobsters and oysters. But gradually, as the human race became a little tamer and a little more domesticated, and commenced to tire of a diet that consisted almost exclusively of dead animals, and added a little grain to its highly irregular meals



(The Hand)
THE TORPEDO

(prehistoric man either gorged or starved and as a result rarely lived to a ripe old age, as we know from most of the skeletons we have found), and as here and there a few tribes were growing tired of wandering and starving and starving and wandering, and settled down to spend their days in comparative leisure among the pleasant pastures of a hillside; as now and then some more than ordinarily intelligent female among the beasts of burden discovered some new variety of grain that could be raised on little patches of fertile earth, painfully plowed with a sharp stick; as all these many things happened (and they took tens

of thousands of years to happen) there arose a demand for a more practical method of crushing certain foodstuffs than that provided either by the hand or by the hammer.

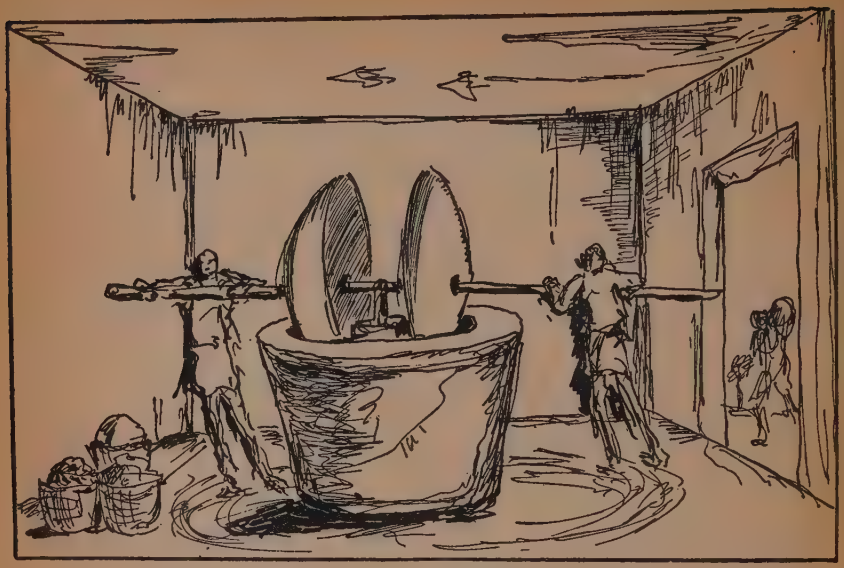
That demand, revaluated into the terms of inventions, meant the gradual change of two human hands into a mortar and a pestle. And when people had grown exasperated with the

(The Hand)

THE MORTAR

eternal pounding and hammering and hammering and pounding that were necessary to produce even the smallest amount of meal or olive oil, the mortar grew quite naturally and unavoidably into the mill.

At first the grinding stones of the mill were moved by human labor. Two men or sometimes a horse or a mule, walking in a circle, pushed the heavy contrivance with slavish regularity and accomplished remarkably little. Until the Romans invented such a method of transmitting power that henceforth an obliging brook or river would do the work of the hand.



(The Hand)

THE HAND-MILL

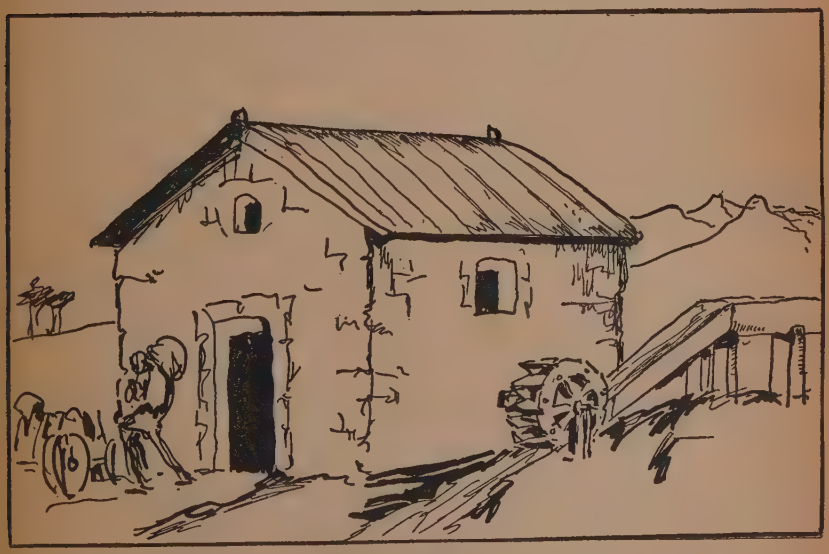
That water-wheel was a great success in those parts of the world where there were mountains, but it was of little use in flat countries. Those lands, on the other hand, were abundantly possessed of a sort of motive power which was not quite so common in the countries bordering upon the Mediterranean. That was the wind. And soon all over northern Europe small wooden structures with a couple of grinding-stones safely tucked away in their basement were lifting their four hands to high Heaven, asking that they be allowed to relieve man from his drudgery.

Originally (that is to say as early as the twelfth century, when mills seem to have come into common use in the Low Countries) these artificial hands were placed on rafts, so that the whole machine could be moved around whenever the wind changed. Later on the top of the mill was built in such a way that it could be moved and then the wings began to perform a hundred different tasks formerly entrusted to the human hands, such as

sawing wood, making paper, preparing snuff and spices, doing the work of the slow-moving old irrigation engines, getting rice ready for the market and what not.

But all these different industrial processes depended for their success upon a steady supply of wind; and in those countries which were far away from the sea the windmill was not steady enough and if they had no water-power either, they were obliged to work their machinery either with men (a method which was inefficient and slow) or with horses (which meant greater speed but also a much greater overhead, since horses had to be bought for ready cash, whereas women and children could be had for only a couple of pennies a day). It was, therefore, necessary to invent a new form of moving power, one that should be absolutely independent of the elements and that should be reasonable in price.

Now almost since the beginning of history people had known



(The Hand)

THE WATER-MILL

that a certain black substance which was dug out of the soil (it sometimes lay very near the surface) would make excellent burning material, much better than wood or peat or dried seaweed. The Romans had called it "carbo" (see our word "carbon"). The Greeks had called it "anthrax" (see our word "anthracite").

(The Hand)

THE WIND-MILL

Our own immediate ancestors, when they emerged from the forests of central Europe and learned the first rudiments of civilization, called it "kol." We call it "coal" and it is nothing but a form of condensed energy which was stored up billions of years ago when the sun was very hot, when the earth was very moist, and when the greater part of the globe was covered with trees which grew to enormous height.

The Romans and Greeks had tried to get at this condensed energy in a wholesale way, but they were bad mining engineers and knew of no better way to gather coal than to let slaves scratch at the brittle substance either with their bare fingers or with

stone hammers, methods which on the whole were not very successful.

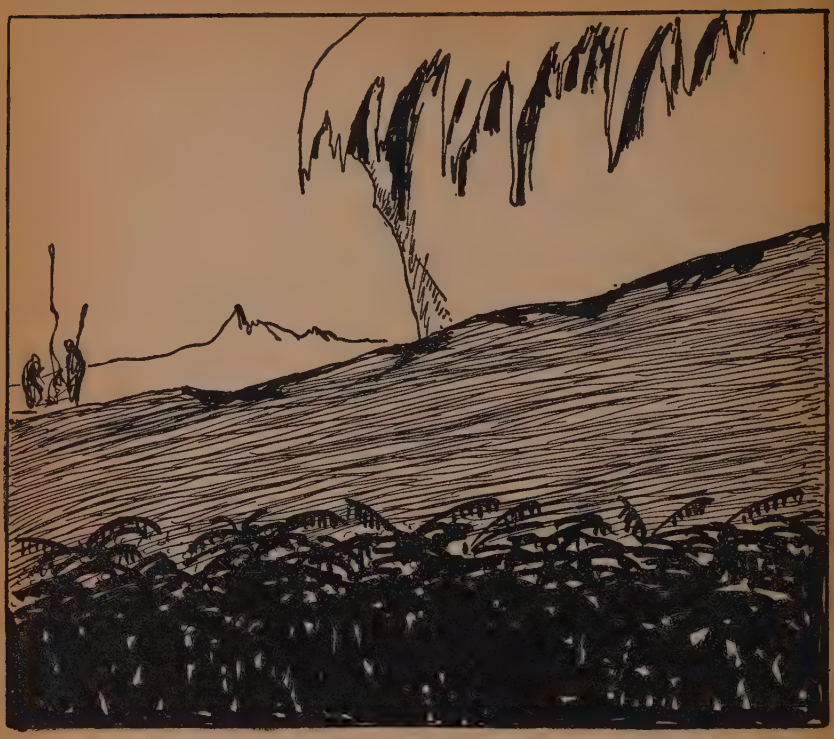
During the seventeenth century, however, with a return of commerce and international trade, there was an increasing demand for coal and England, which was the leading manufacturing

(The Hand)

PREHISTORIC ENERGY IN THE MAKING

nation of that period, was beginning to work its mines in all seriousness. The mine shafts in those days were mere makeshift affairs. They rarely went very deep below the surface of the earth, but even so it was found impossible to keep them free from ground water except by a constant use of that substitute for the hand which was known as a "pump."

Those pumps, however, were very costly. At first they were worked by human hands. Then horses and mules were substituted for men and women. But even so it was difficult to keep the shafts dry and the pumps ate up whatever profits were made from the sale of the coal. All over the world, wherever there were mines,

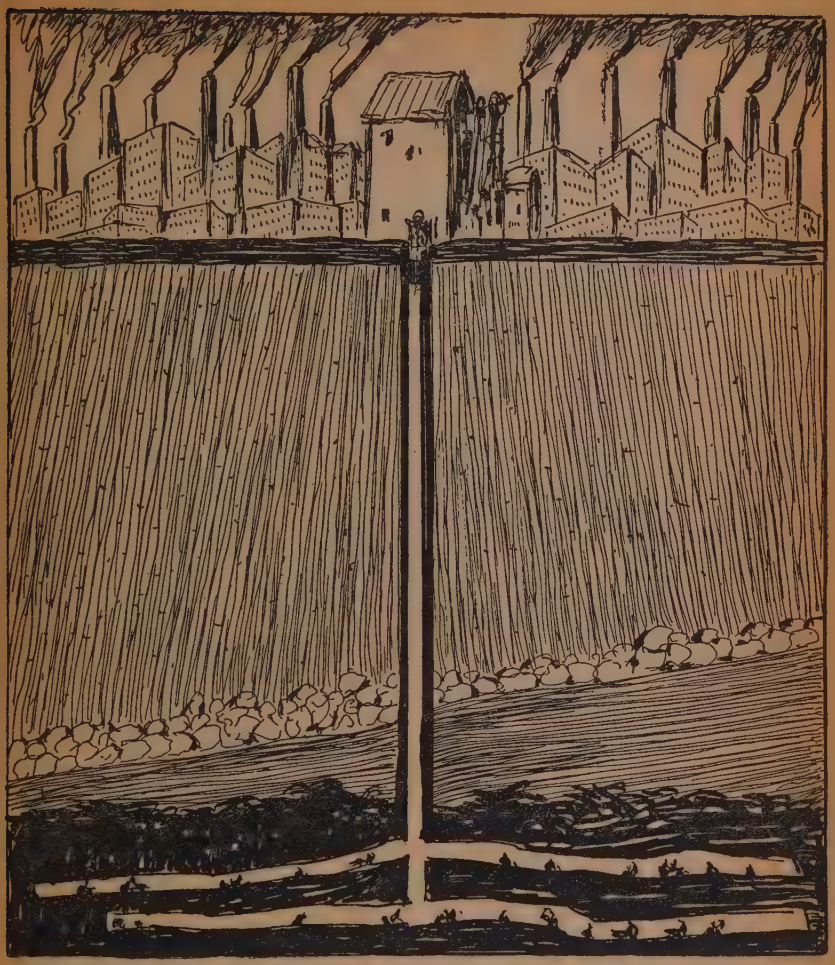


(The Hand)

PREHISTORIC ENERGY CONDENSED

there were owners who were loudly clamoring for a machine that could replace the horses and the human hand and do the work regularly and at small cost. Then it was that a few scientifically minded citizens began to remember something which they had read in a book about an artificial slave, made of iron and fire, which had been operated in Alexandria, more than fifteen centuries before, and which was said to have been a complete success.

Unfortunately the legendary "fire-engines" of Hero had gone to the scrap-heap together with the Roman Empire and the details about their construction were a bit vague. Nevertheless, a number of courageous Germans and Frenchmen and Englishmen set to work to reconstruct the creatures and within



(The Hand)
PREHISTORIC ENERGY RELEASED

a comparatively short space of time they were able to announce that the trick had been done, that the rejuvenated "fire-machine" stood ready for inspection.

But as has happened so often in the history of human inventions, it was one thing to coax inanimate matter into action, but it was quite a different problem to overcome the inertia of the

general public. This need not surprise us. The majority of the people on this planet are no heroes. Like the trees and the little fishes and the beasts of the field, they want to play it safe, and they want to be assured against all sudden changes in their living conditions, which would mean the reshaping of their familiar old habits. The pioneers of this world are those in whom the gambling spirit is greater than the desire for safety.

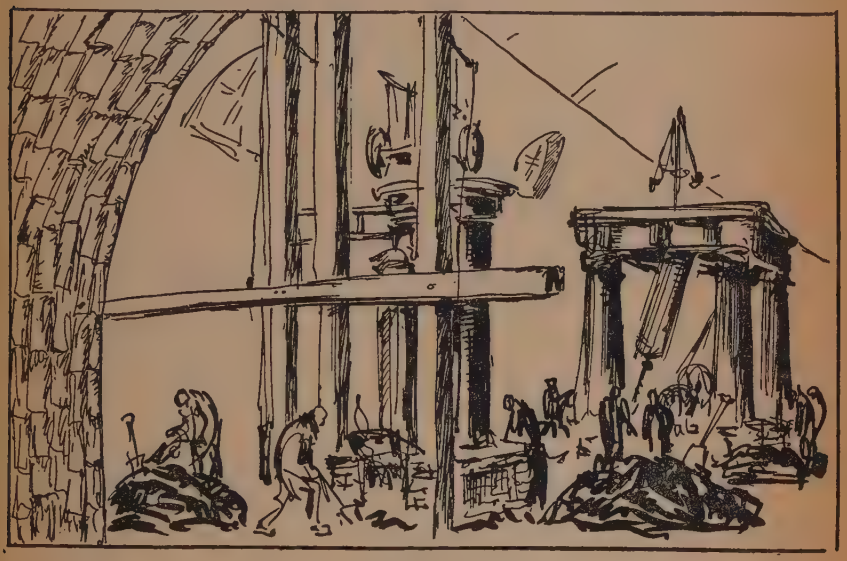
That is why they are invariably hated by their neighbors and rarely (unless they live to be a hundred) receive any gratitude for their services from the rest of the community.

That is why Denis Papin and Della Porta and Giovanni Branca and the Marquis of Worcester experienced such great difficulties when they tried to make little drops of water do the work of the human hands. That is why Fiske in America was driven to suicide.

Their stamping, snorting, groaning wheels and levers were regarded with deep suspicion by all sound citizens. Those rumbling contraptions of stone and steel and iron, belching fire and spewing smoke, were sure to cause the most terrible changes in the living conditions of millions of people. Those millions, since time immemorial, had been accustomed to be abused like veritable beasts of burden. They had long since accepted their fate. They were now merely animated hands, destined to pull and carry and hoist from the cradle (or at least from their fifth or sixth year) to the grave. It was not a very happy fate, but it held no surprises. It was safe. And that was really all that the average man wanted.

When the inventors told these poor slaves of the billions and billions of condensed man-power and horse-power that lay stored up beneath the surface of the earth, that could be set to work to do the tasks now painfully performed by human hands, they asked only one question: "Will it mean that I have to change my own habits, and must I perhaps learn to do something else?"

And when they were answered "Yes," they did not care to listen to any further explanations; how in the end they would gain enormously by being relieved from a hideous job and how it would mean more wealth, less drudgery, fewer broken backs to all mankind. Those particulars did not interest them. They would have to discontinue the habits of a lifetime, they would



(The Hand)

THE STEAM ENGINE

be obliged to live differently from their grandfathers and great-grandfathers. That was enough to make them condemn the new artificial hand as a blasphemous and arrogant effort to rival the powers of God. That was enough to make every minister in the land decry the brazen sinfulness of those who in their pride endeavored to improve upon the handiwork of the Almighty.

James Watt was successful not only because he improved the fire engine in such a way that it could be worked without the constant assistance of the human hand, but primarily because he was one of the latest of the fire-engine enthusiasts to appear

upon the scene. When he took out his patent, the world had already listened to a hundred and fifty years of propaganda in favor of steam as a substitute for muscle and the strength of the opposition had considerably weakened.

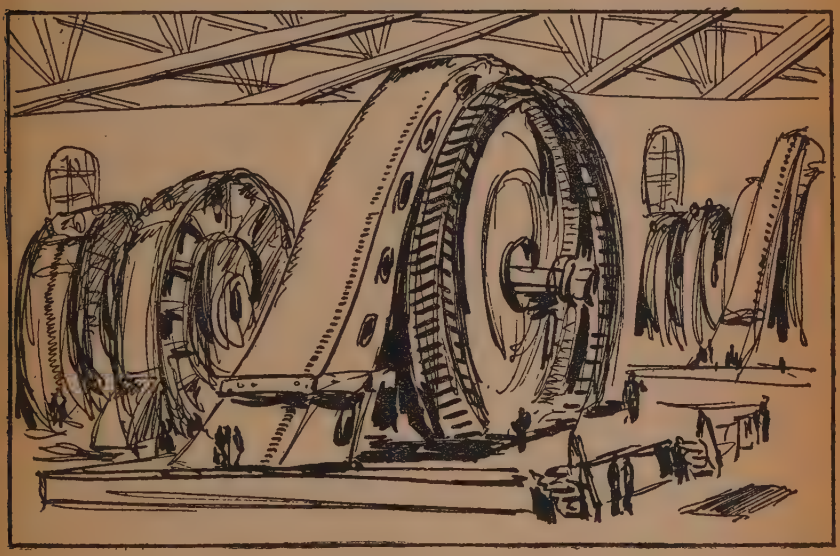
That was the beginning of a new and curious chapter in the history of the human race.

The steam engine had been invented to replace the horses which had been set to work to replace the human hand in working the pumps of a mine. Gradually it was discovered that the same engine could be used for a multitude of purposes. Then all the world began to use fire machines. Then it became necessary to develop more and more coal mines, because the hungry maw of the fiery monster devoured millions of tons of coal a day. Then more and more mines had to be dug and larger and larger quantities of prehistoric energy had to be brought to the surface of the earth to keep the engines going. Then it was necessary to build still more engines to work the mines. Until coal had become the recognized ruler of the world and the nation that was possessed of the largest number of coal mines could dictate its will to all its rivals.

It was not exactly a happy development and not at all what the inventors of this mundane substitute for the hand had foreseen. Contrary to all noble expectations, the same people who only a few years before had been relieved from a most degrading form of manual labor were now being enslaved by an inanimate creature which was even less merciful than the human taskmasters of twenty years before.

There is only one consolation. The era of the coal-fed engines seems destined to be only an intermediary period of development. Even to-day it is showing signs of coming to an end. Not because the subterranean storehouses of condensed prehistoric energy are in any danger of becoming exhausted (we are still far from that point) but because there are too many disad-

vantages connected with the use of coal. It is hard to get at. It is messy. Coal mining, ever since the beginning of the industry, has been the sort of labor that is left to the most abused classes of society. It is a dangerous trade. People hate to work several thousand feet underneath the surface of the soil when the sun shines pleasantly upon the rest of the world. Both the mines and the storage places for coal will disfigure any landscape for



(The Hand)

THE DYNAMO

miles around. And then there is the cost of transporting the coal from the mine-pit to its final place of employment.

As long as the steam engine was the only substitute for the hand that could develop the power necessary to make the million and one wheels of our modern engines go round, we had no choice in the matter, as those of us who remember the coal strikes of a generation or so ago well know.

To-day in many lands, whenever the miners take a vacation, the hand of the community becomes paralyzed and every one

feels the results either in the form of hunger or cold. But our dependence upon coal is no longer as absolute as before. For one thing, the steam engine is no longer the main source of power. When it was about sixty years old, it got a little brother which was baptized Dynamo after a long-forgotten Greek grandpapa who had belonged to the Power family. During the first few years of its existence, the child was very feeble. For a time it even looked as if it would not survive and as if the great fortune which its godfather, Michael Faraday, had predicted for it, would come to nothing.

But with the increasing demand for power and power and ever more power, this method of converting mechanical energy into electric energy proved too valuable to be relegated to the museum of mechanical curiosities. To-day the dynamo is quite as valuable to society as the steam engine, in replacing the labor of the human hand, and with its softly purring ways it has become a great deal more popular than its puffing and wheezing older cousin.

But about half a century ago, when it seemed that henceforth the steam hand and the electric hand would divide all the work in the world between them, the old cronies were pleasantly surprised by the arrival of still another little brother which grew so fast and so furiously that for a short time it looked as if it would drive both its older and more respectable relatives out of existence. The name of the upstart was Motor and it lived on decayed animal matter, just as Steam Engine subsisted on old vegetable mold.

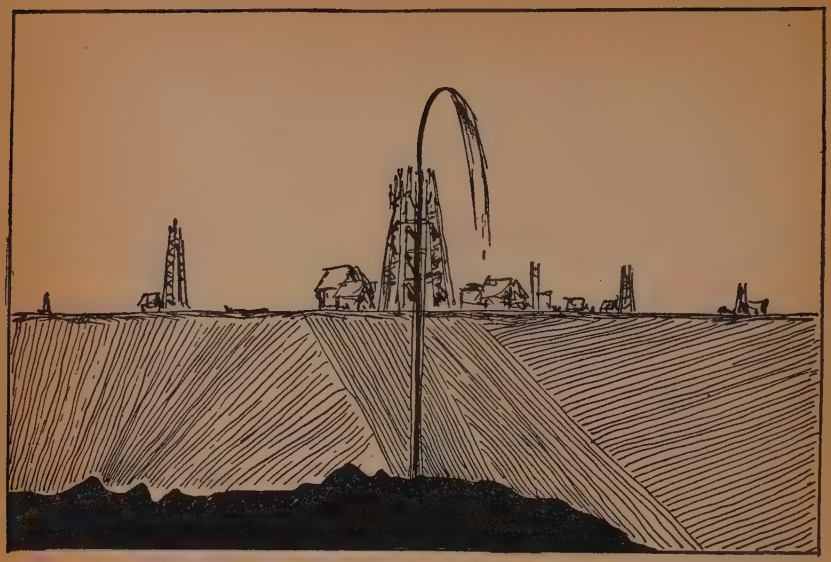
It derived its daily pabulum from vast reservoirs of an oily substance which lay hidden deep below the surface of the earth, and the existence of which had been suspected as long as forty centuries ago. In those days the oil that occasionally oozed forth from the pores of a rocky soil had been used only for purposes of illumination. What this earth oil was, that nobody

had been able to tell, and even to-day with all our knowledge of chemistry we can only guess at the origin of that indispensable form of fuel. For although we seem to have reason to suppose that petroleum is an animal rather than a vegetable product and consists of the liquefied remains of billions and quadrillions of microscopically small creatures who lived in the seas of this earth millions of years before our planet assumed its present shape,

(The Hand)
OIL FIELDS IN THE MAKING

we do not know for sure and although little drops of gas oil (a substance distilled out of crude earth oil) have become so important that the fate of empires has come to depend upon them, they continue to be as much of a mystery as they were in the days when the people of Ecbatana and Babylon burned each other's cities with the help of a couple of barrels of rock oil.

The motor, however, has never shown the slightest interest in the scientific composition of its food. It has kept on developing at a furious rate of speed and as a substitute for the hand



(The Hand)
THE OIL WELL

has rapidly gained a most tremendous popularity. It is a voracious creature and in order to keep it satisfied, we have been obliged to tap the prehistoric containers of liquefied animal matter with more haste than is quite desirable. Indeed, many serious scientists have taken alarm and are predicting the ultimate extinction of the internal combustion engine through the lack of proper nourishment.

This, is seems to me, need not worry us very much. Man, having at last tasted the joys of comparative freedom from drudgery, will never again submit to the slavery of his grandfather's day without putting up a terrific fight. Everywhere he is experimenting with new substitutes for the human hand. He is building new sorts of mills that shall utilize the air-currents. He is forcing waterfalls and mountain streams and the tides of the ocean to work his dynamos for him. He has cast a reflective eye upon the rays of the sun which thus far have gone completely

to waste. And he is trying (not very successfully so far) to liquefy coal or to devise a new sort of alcohol that he may use them as substitutes for the oily food upon which his rapacious but delicately constructed slaves of the great Motor family depend for their happiness, and without which they positively refuse to turn a wheel or do a stroke of work.

Predictions about the immediate future of technical developments have greatly contributed to the sum total of this world's literary nonsense. For all I know some inventive genius may devise a method by which the diminutive cyclones created by the wings of wasps and humming-birds may be converted into the energy necessary to run all our engines. And I am quite certain that long before the last oil field shall have been tapped of its last drop of oil, the combined intelligence of the human race will have discovered a new way in which to keep these engines running.

For nothing is quite as contagious as a love for comfort and people who have been accustomed all their lives to drive in motor cars are not going back to the stagecoach if it costs them their last penny to find a suitable substitute for the smelly stuff that pours forth from the bowels of the earth.

. . . . . .

I am not exactly a wild enthusiast about all the achievements of the species of mammal to which I happen to belong. It often seems to me that our dog Noodle derives a great deal more happiness out of his canine existence than most of my friends. But that after all is a mood, and a passing mood. For the amiable dachshund lives in a world "all found." In exchange for nothing more substantial than that loyal devotion of which he seems to possess an unlimited supply, he is provided with a decent bed, plentiful food and an occasional bath.

Perhaps if all cares and worries were removed from me, provided I were fairly obedient, desisted from chasing the neigh-

bors' cats and sometimes were willing to come when I was called, I also might look upon life with serene contentment. But I should miss the main satisfaction which gives us an advantage over the rest of the animal kingdom—I should never be able to realize that this world, as the late Galileo Galilei is said to have observed, that this world *does* move. I do not mean in the sense of spinning around the sun. I mean in the sense of growing to be just a little more intelligent, a little less cruel and a little more bearable for the majority of my neighbors than it has ever been before.

The unfortunate fact that the hand is forging ahead by leaps and bounds while the brain is developing its faculties with exasperating slowness—that mechanically we live in the year of grace 1928 while spiritually we are but little removed from our earliest ancestors—that in short we are naught but cave-dwellers going on a joy-ride in a Chevrolet—all this I realize full well but I refuse to listen to the defeatists who urge me not to inquire any further into the secrets of the unsolvable because the thing is hopeless; because we are foredoomed to failure; because all our much vaunted knowledge only seems to lead to ruin and unhappiness.

The Great War was not caused by the fact that we knew too much.

It merely proved in a most disastrous fashion that we did not yet know enough.

And the same holds true of that social unrest which grins at us from all sides. It is foolish to say that this widespread discontent is the result of the mechanical and industrial revolution which followed in the wake of the substitute hands respectively called the steam engine, the dynamo and the motor. I do not mean to deny the existence of a great deal of misery or to overlook the fact that many of the people whose business it is to keep

these inanimate monsters alive hate their charges with a deep and all-consuming hatred and have a good reason to do so.

But these conditions are beside the point. They are details. They have nothing to do with the case. One might as well argue against the widespread use of opiates in the field of medicine and insist that the sufferers in our hospitals be left without the relief afforded by cocaine and morphine because a few weak brethren

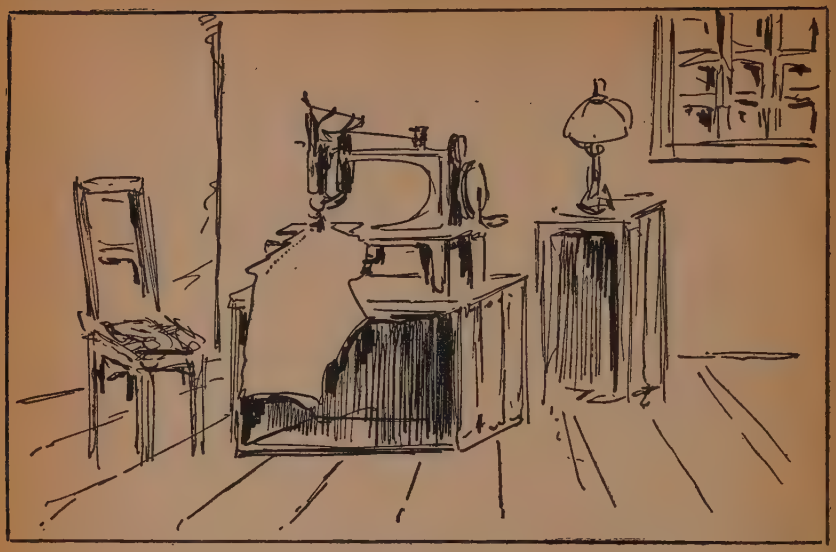
(The Hand)

THE WORKMAN CARRYING HIS TOOLS

sniff the stuff for the fun of it and have to be suppressed by the police when they begin to make a nuisance of themselves, and one might just as soon denounce automobiles because occasionally a silly child of twelve runs away with his papa's car and comes to grief in the village pond.

No, the Iron Man has come to stay and all the fair words in the world will not deprive him of one iota of his power.

The day when the workman did everything with his own hands is gone for good and all. The day when the workman carried his



(The Hand)
THE TOOL IN THE WORKMAN'S HOME

modest bag of tools (his reënforced hands) on his own back is gone, except in a few of the highly skilled trades. The day when the workman sat at home and sweated over some miserable mechanical contrivance which had been loaned to him by some one rich enough to buy the costly tools which were out of reach of the average artisan—that day, too, is fast approaching its end. The day of the sublimated and centralized communal hand known as the factory has arrived and it would be as foolish to fight this useful institution as it would be criminal to close our eyes to the tremendous difficulties which arise whenever entire nations are suddenly forced to adopt radically new methods of thinking and living, long before their minds have been prepared for the change.

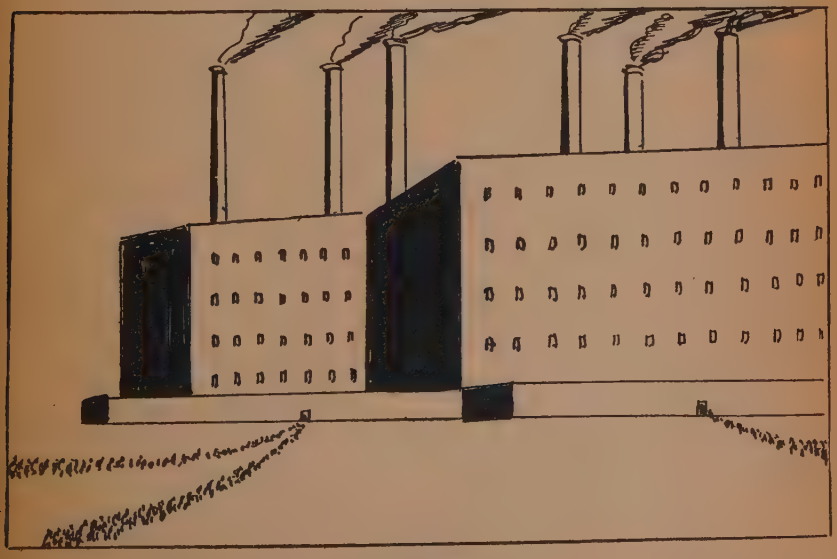
The machine-age has descended upon us almost as unexpectedly as the ice-age. In the panic that followed a great many things happened that invariably happen during panics and which are seldom pleasant to contemplate. But the human race which was able to survive the infinitely greater economic and

social revolution caused by the appearance of the glaciers will surely find a way out of the present difficulties.

To-day in America even the poorest of the poor have eleven silent slaves who work for them while they are devoting their attention to something else—dumb but willing creatures who carry and fetch and lift and do a multitude of things which only a century ago had to be lifted and carried by human hands and human backs.

To-day even the slummiest of slum-dwellers is able to enjoy certain luxuries of which Charlemagne, in all his glory (and he was a most powerful sovereign), had not dared to dream from fear of being dragged before a commission in lunacy.

This sounds like the after-luncheon speech of a professional booster employed by some public-utilities corporation to convince the Chamber of Commerce of a seventh-rate town of the necessity for building a supplementary electric plant.



(The Hand)

THE FACTORY

(The Hand)
OUR UNKNOWN SLAVES

Heaven forbid!

The gigantic substitute hand of our modern age, badly guided and totally uninspired, left to the mercy of greedy masters, is still capable of an infinite amount of harm.

But by the same token it is capable of an infinite amount of good.

The choice, my friends, is with ourselves.

CHAPTER IV

From Foot to Flying-Machine

THE poet may sing about the "light winged foot" (Shakespeare has something to say upon the subject in "Romeo and Juliet"), but to the average quadruped and biped the foot has ever been a sore subject. Painfully exposed to every sharp stone and thorn, forced to carry all sorts of burdens and gallop or trot or swing its owner to safety, the foot has always been one of the most vulnerable parts of the body. Wherefore, man, as soon as he had consciously ceased to be an animal, bethought himself of ways and means to multiply and augment the powers of his slow-plodding hind-paws and let an obliging substitute perform some of the thousands of tasks which thus far had depended for their fulfillment upon the soles of his aching feet.

In the beginning, of course, no one was ever in a hurry. The idea of "time" is of very recent origin. Primitive people are aware of only a few outstanding facts. They knew that day follows night and that night follows day and that a period of warm and wet weather is invariably succeeded by a period of cold and dry weather.

But the modern notion of time as a substance which is well-nigh tangible, which can be converted into definitely definable

(The Foot)

THE HUMAN BEAST OF BURDEN

quantities of labor, which can be revaluated in terms of profit and loss—why, it would have made the people of 15,000 years ago roar with laughter. A Bushman listening to the theories of Albert Einstein would not have been more surprised and bewildered than a citizen of the Stone Age receiving instructions in the use of a watch or a tide chart.

The element of speed, therefore, unless pursued by an enemy, did not enter into the calculations of our earliest ancestors. But even *Pithecanthropus erectus* had a back, and that back had to be supported by two feet.

It did not matter to him how many hours or days or weeks it took him to go from one spot to another, but it did make a difference (and a very considerable difference) how much he had to exert himself, how many blisters he got on the soles of his feet, how many rivers he had to wade through, how badly his legs were lacerated by the thorns of the underbrush.

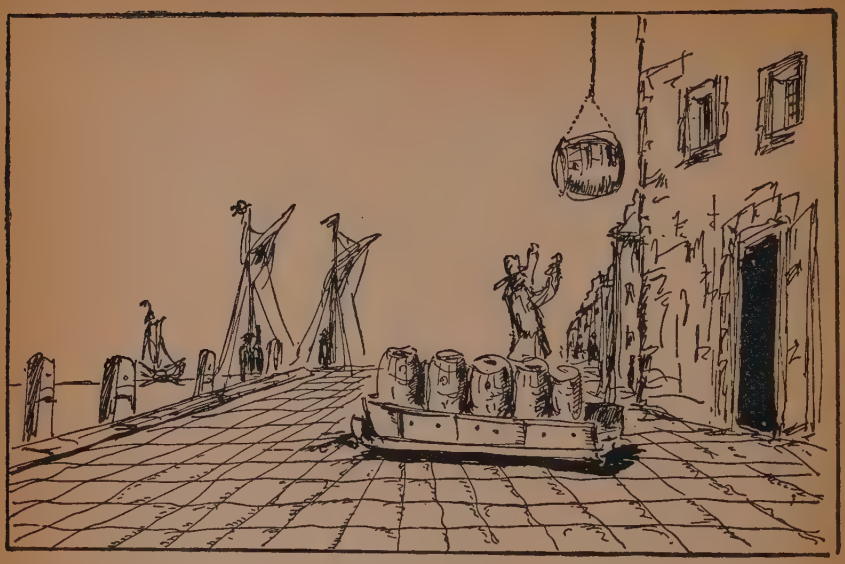
And the search for the multiplied foot began almost as soon as the search for the multiplied hand and on the whole with a greater degree of success. For even some of the humblest animals had learned that it was possible to make certain other animals do what one did not care to do one's self; and following their intelligent example, man at a very early stage in his development enslaved a number of his fellow mammals and used their feet as substitutes for his own.

The horse was among the first to succumb. Once astride his broad back, a man could cover vast distances with a minimum of effort and a maximum of comfort. But it took considerable skill to manage one of these animals and the average person was obliged to walk if he wanted to go from one place to another and be sure that he would get there without breaking his neck.

But walking was not such terrible punishment as long as people lived like the beasts of the field and had not yet accumulated any private possessions. As soon, however, as man had

(The Foot)

THE SLEIGH



(The Foot)

THE SLEDGE

become sufficiently civilized to accumulate a few household goods, he became the slave of his riches and had to carry them around on his back wherever he went. He very soon discovered that one can move heavy loads much more easily by pulling them than by hoisting them to one's back, and when this fact had been definitely established, the traction problem underwent a complete change. It was long before the whole of the planet could boast of a single road, but the glacial period, with its unlimited snow-fields, offered excellent opportunities for making experiments with sledges—flat pieces of wood dragged by human beings or by reindeer.

As time went on, the flat piece of wood was provided with runners. At first these were made out of bone. When metal came into general use, the bone was discarded for iron and finally for steel. But the sleigh retained its original prehistoric form longer than almost any other bit of human machinery.

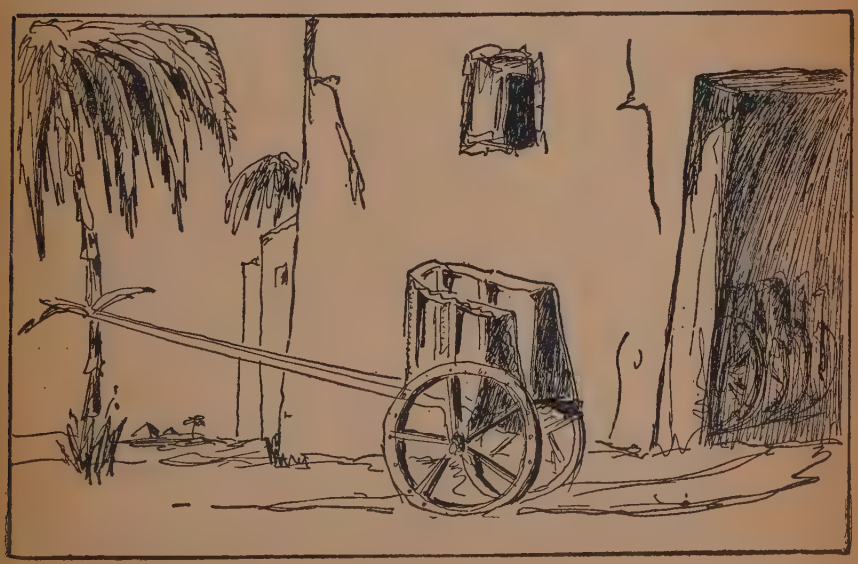
Even long after the invention of the wheel, the sleigh was able to hold its own, and during the seventeenth and eighteenth centuries practically all the hauling in the big commercial centers was done by means of sledges. For wheels were too expensive and it was cheaper to kill a few extra horses than go to a cartwright and let him make a regular wagon.

Where stands the statue dedicated to the memory of the man who invented the wheel?

He was one of the greatest benefactors of the human race and no one ever gives him a thought.

To us, of course, what he did seems very simple. Was there ever a time when man had not yet thought of the carrying possibilities inherent in round discs of wood?

Yes, indeed! Not only was there such a time, but there were vast groups of human beings who never discovered the wheel during all the thousands of years they spent on this earth. Our



(The Foot)

THE EGYPTIAN CART

(The Foot)

THE WHEEL

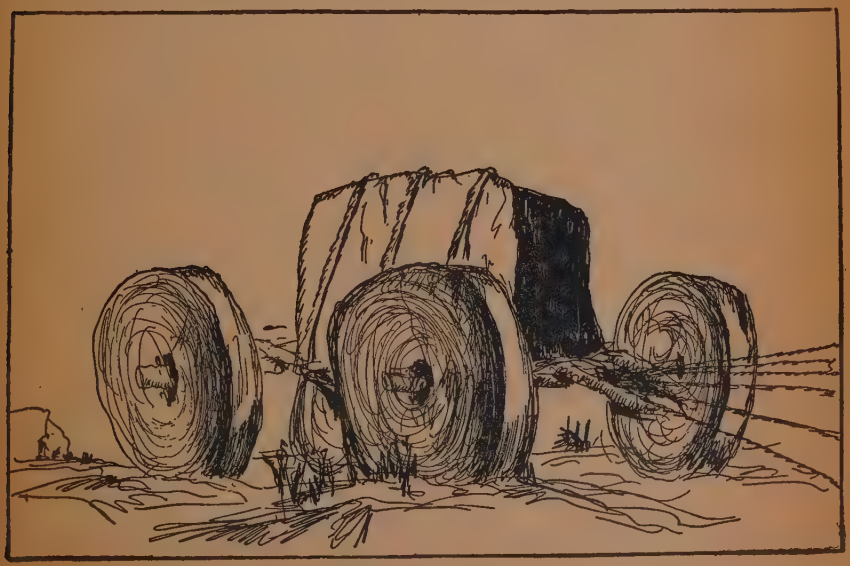
own Indians were ignorant of the existence of the wheel. The carriages of their Spanish conquerors impressed them quite as much as their blunderbusses. Yet the American Indian was no fool. His brain was just as good as that of his European contemporaries. He did marvelous things within the field of mathematics. He was a better astronomer than the Egyptians and the Greeks. But he never thought of the possibility of making himself a wheel, and it may have been one of the reasons why he had lagged behind and fell such an easy victim to the men from the east.

. . . . . .

Our museums contain what are said to be the oldest forms of wheels which were found in the graves of defunct Egyptian rulers. Babylonian sculptures show us bearded potentates hunting ferocious lions from the safe vantage points of small armored rickshaws. Homer juggles with carts as he juggles with kings.

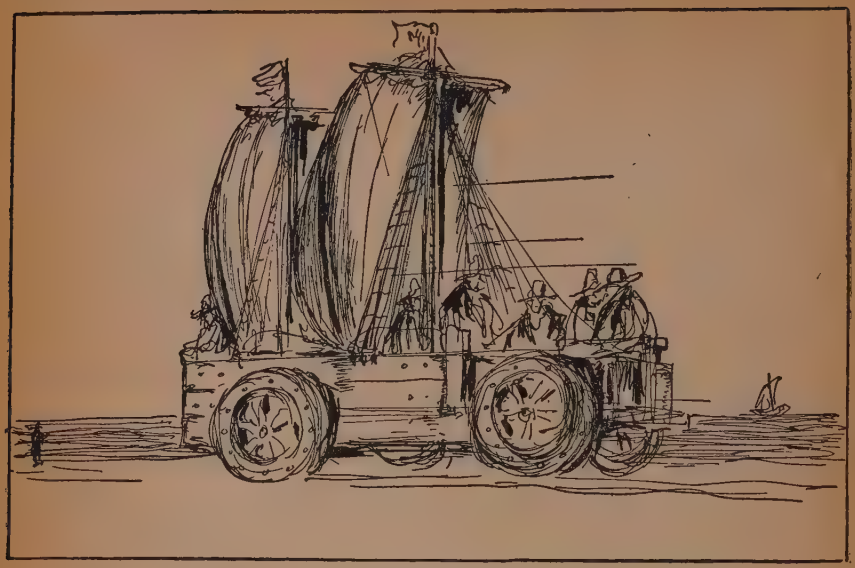
The vehicles of the Scriptures do not content themselves with the highroads of this earth, but boldly burst forth into the clouds and storm the pinnacles of Paradise. Indeed, the whole history of ancient times is thickly interwoven with legends about fiery chariots and heavenly wagons, and whenever people wished to render particular homage to one of their gods they depicted him as a dare-devil driver on board a golden cariole, offering to race the sun or steal the moon or do whatever took the greatest amount of skill with horses and with wheels.

It is doubtful whether those earliest carts were ideal instruments of locomotion. People rarely used them unless they were obliged to do so through sickness or old age. Whenever possible, they stuck to the backs of horses and mules. Then came the period of neglect, which followed in the wake of the disintegration of Rome, when the wagons were deprived of those roads without which they could not possibly operate. Then, things on wheels became great curiosities—expensive luxuries like private yachts



(The Foot)

THE FIRST CARRIAGE



(The Foot)

THE SAILING CART

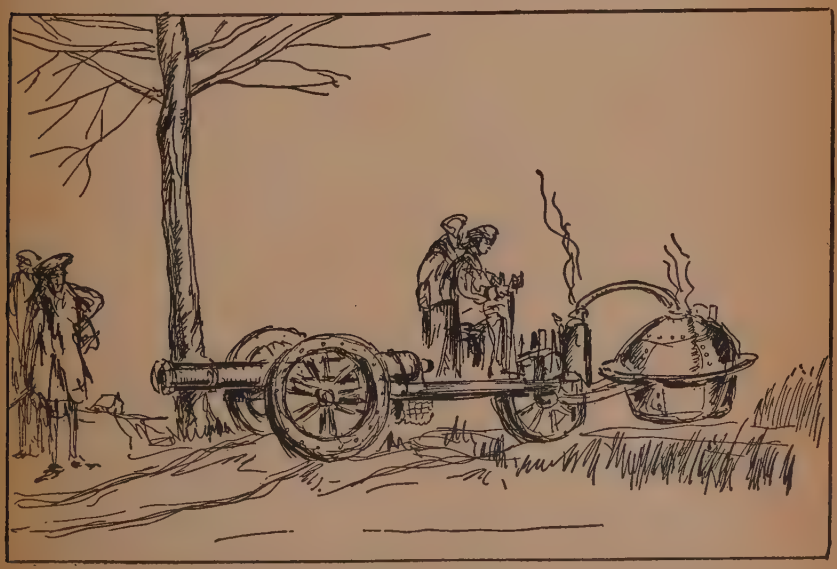
or special trains. Finally in many parts of Europe they disappeared altogether until well into the sixteenth century, when the revival of the overland trade caused a demand for more efficient methods of transportation. Then at last the old Roman wagons made their reappearance upon the highroads of Europe and the pack-horse, the common carrier of the Middle Ages, no longer sounded his tinkling bell through the narrow thoroughfares of the Swiss villages. But no sooner had the lumbering drays begun to move the spices and textiles from East to West than we hear of efforts to make them a little less dependent upon the endurance and good will of donkeys and mules. It was the day when sailing vessels were beginning to replace the ships moved by the oars of galley-slaves. The obliging wind was doing wondrous things on the waters. Why not give it a chance on dry land?

A clever Fleming tried to combine the idea of vessel and cart and erected a sail upon his four-wheeled vehicle. The thing

worked. It worked wonderfully well, but only in one direction. It refused to tack. And it went to the scrap-heap together with several other futile attempts to make the wheels of wagons go round by means of man power.

But for hundreds of years they were unsuccessful. Then at last some one thought of the possibility of moving the multiplied foot by means of the multiplied hand. It is not pleasant to reflect that the first combination of the two was constructed for the benefit of that other form of the augmented hand, which was known as the cannon. But that is the way it happened.

In the year 1769 a Frenchman by the name of Cugnot came lumbering down the road of Versailles with a steam-driven vehicle that had been built for the French War Department to find out whether steam could supplant the horse as a means of moving heavy guns from one place to another. The Cugnot fire-wagon departed from the current model which had insisted that carriages

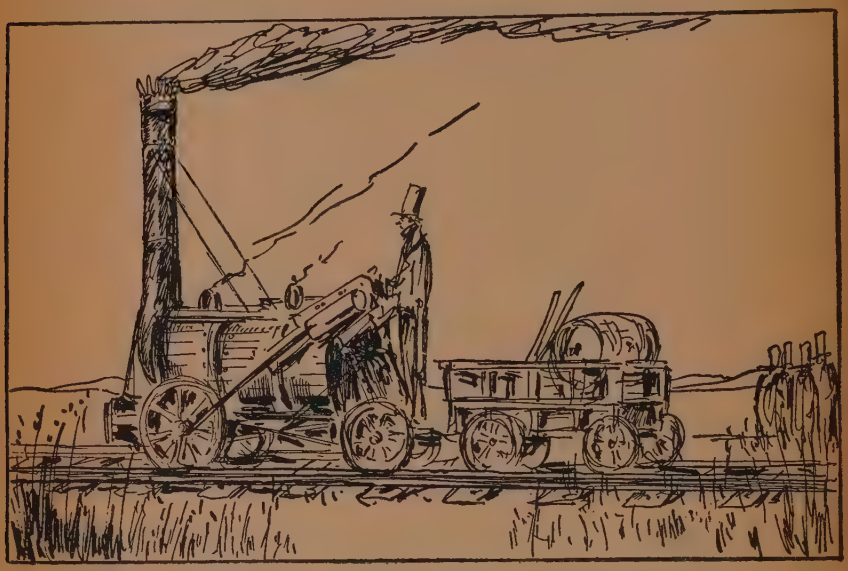


(The Foot)

THE STEAM-DRIVEN FOOT

be built in the image of bipeds or quadrupeds. It did not have two or four wheels, it had three, and it sped along the ill-paved highways at the rate of four kilometers an hour.

It would have been a success if the inventor had been able to keep it on the road. But the creature insisted upon ambling all over the fields and the brakes, too, proved to be far from



(The Foot)

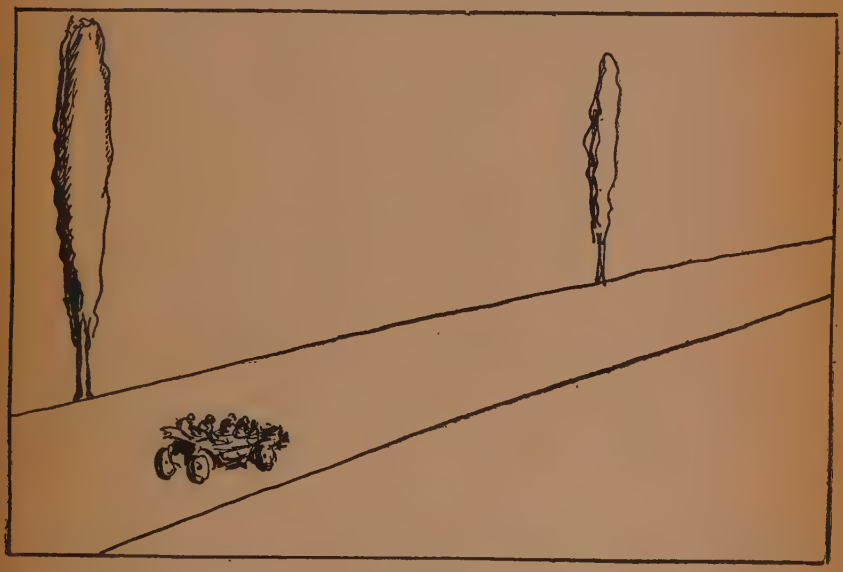
THE LOCOMOTIVE

reliable. And so nothing came of the experiment. It was allowed to be dropped. Soon it was forgotten.

This failure may have been due to the faulty plans of the engineer who constructed the machine, and then again it may have been the result of that strange hostility towards all new ideas which characterizes the average military mind. The French artillery experts declared against the new machine, just as fifty years later an Italian condottiere by the name of Bonaparte was to deride the notion that one could cross the Channel in a steam-driven vessel, and just as our own War Department,

seventy-five years later, was to refuse to consider the use of anæsthetics in the field-hospitals because chloroform was declared to be both useless and dangerous.

Needless to say the Sam Wellers of that day, as soon as they heard of the horseless carriage, raised a terrible to-do and from the high perches of their stately coaches they denounced the



(The Foot)

THE MOTOR CAR

idea that man could travel under his own steam as an impious defiance of the will of God, which would destroy the crops, would make an end to horse-breeding, and in that way would destroy the Empire.

But born inventors are like born painters or born composers. Those good people (as is often believed by the uninitiated) don't compose or paint or invent or organize trusts because they want to. They perform those manifold tasks because they just can't help themselves. It is in their blood. They have been struck with some incurable form of divine curiosity. It is not necessary for

(The Foot)

THE SKATES

them to live. But it is necessary for them to invent or compose or paint—or to die from sheer discontent and impatience.

Whenever a new idea is in the air, ninety-eight per cent of the people pooh-pooh it and write to the papers and urge the editors to use their great influence to persuade those "so-called" aviators or Arctic travelers or saxophone players or what-have-you from corrupting the youth of the land by their bad example.

Fortunately the other two per cent rarely hear of those noble efforts on the part of their fellow citizens, for whenever they can get hold of a newspaper, they need it to stoke the furnace and keep the family from freezing to death. Even if they were called upon by weeping ladies of some patriotic organization and asked to desist, they would be obliged to disappoint the dear sisters. For most of them are just a tiny little bit crazy. Which is just as well. Would sensible people go through the hardships of our intellectual pioneers? Of course not. And if all this

world were composed of normal folk, we should still live among the trees, swinging gayly from branch to branch with the assistance of long, prehensile tails.

It is no more than fair that I should make this little detour right here, for I am about to tell you of the invention of another sort of multiplied foot which was fought harder and more bitterly than almost anything else and which goes by the name of the railroad train.

Richard Trevithick, William Hedley and George Stephenson are the people who are generally supposed to have been responsible for the invention of the Iron Horse. They lived in an age of respectability, snuff and slow means of transportation, and they were made to feel that their enthusiasm was entirely out of place in a country of decent Christians.

To-day all three have statues. But while they were still on this earth, the respect of the community showed itself in slightly different forms, such as cat-calls, diverse specimens of defunct

(The Foot)

THE FIRST BRIDGE

cabbages and Acts of Parliament interfering with their nefarious designs upon the tranquillity of country estates. When even the latter (the Acts of Parliament) proved to be of no avail, committees of learned professors were instituted to predict (at the hand of innumerable blue-prints and statistics) that the idea of steam-traction was foredoomed to failure and that money thus

(The Foot)

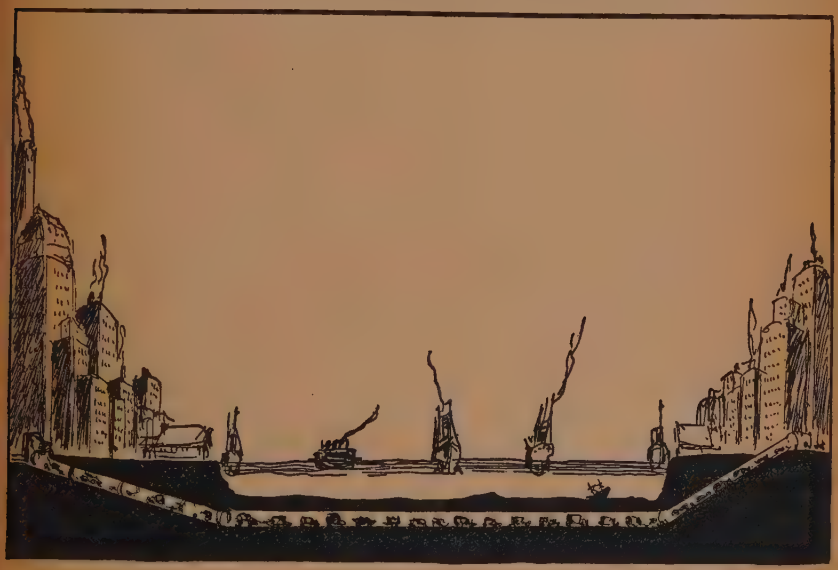
THE ROMAN BRIDGE

invested might as well be thrown into the Thames. And when finally the first road of iron rails had been completed, another dozen years of wrangling and arguing and persuading passed before Stephenson was able to convince his directors that the engine should be placed on wheels and should be part of the moving body rather than a stationary affair at one end of the road arranged to haul the carriages forward and backward by means of a complicated system of ropes.

That was in the year 1825.

The idea of a machine that should be driven by means of

regular explosions occurring in its "innards" is a very old one. The Greeks had speculated about the possibilities of such a substitute for the hand. But they had never been able to make one. The trouble was that they did not know enough. They were possessed of brilliant minds but they had not yet accumulated a sufficient number of scientific facts, and so they remained



(The Foot)

THE TUNNEL UNDERNEATH THE RIVER

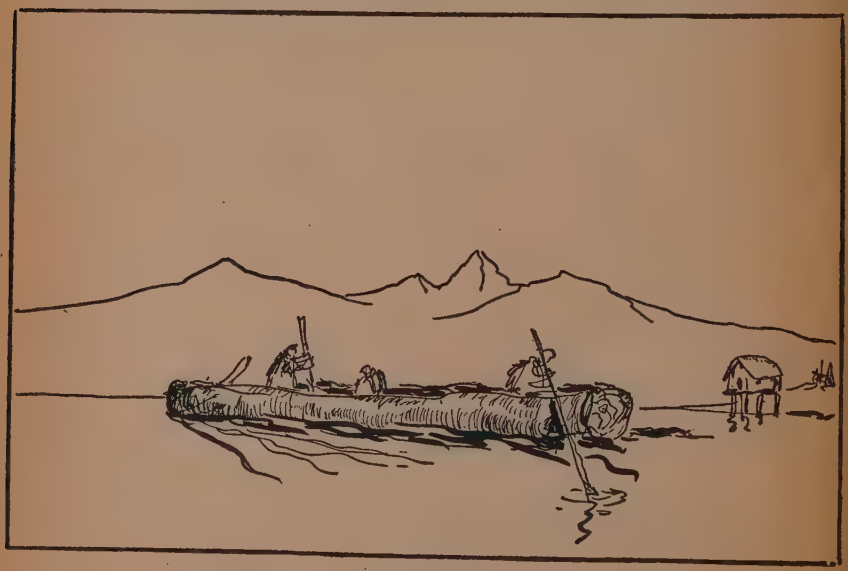
the prime "guessers" of the old world who "guessed" at everything from statecraft to motor cars and often "guessed" pretty nearly right.

They were followed by the good pious burghers of the Middle Ages, who were equally indifferent to "knowing" and "guessing" as long as they were allowed to "believe." When after years of painful experiment it was established beyond the shadow of a doubt that a too thorough reliance upon the joys of the future was apt to lead to a little more Hell-in-the-present

than was quite comfortable, the work of the old Hellenes was continued where they had left off and the internal combustion engine was once more taken out of its Attic shed and was made an object of serious study.

Huygens, the Dutch physicist, played with the idea of a machine that should be moved by the explosion of small amounts of gunpowder. While he was trying out a variety of gunpowder samples, the royal house of Sweden bought itself a wagon "driven by a mechanical contrivance" (details unknown) which had been constructed by a Nuremberg watchmaker. The old bus, however, proved much too speedy for the roads, for it often made as much as a kilometer and a half per hour and could go on forever. A few years later, no one less than great Isaac Newton, the man who discovered the law of gravity, occupied himself with a car that was to be driven on the principle of the rocket.

But it was not until the middle of the last century, when the



(The Foot)

THE FIRST BOAT

(The Foot)

THE FIRST BOAT CROSSES THE CHANNEL

explosive qualities of distilled earth oil had been definitely established, that the automobile (in its modern form) made its first appearance. Both France and Germany were busy with experiments when the war of 1870 broke out and caused a slight delay. But fifteen years after this senseless and disastrous struggle, horseless carriages, not moved by steam but by "explosion motors," were beginning to make their appearance upon the European highroads and were at once the object of marked attacks. The railroad companies completely forgot what had happened to themselves only a short while before and denounced these roughriders of the highroads as "enemies of the public safety." Private citizens shouted loudly about the rights of pedestrians, and parliaments as usual made themselves conspicuous by passing laws which forced the owners of cars to have their vehicles preceded by guards bearing lighted lanterns or red flags.

. . . . . .

All these inventions which served to multiply the power of the foot contributed their share towards that great revolution in the social fabric which commenced the day James Watt took out a patent for his improved steam engine. They completely changed the old idea of distance. They decreased the size of the globe by at least sixty per cent and gave the world a new

(The Foot)
THE SAIL BOAT

conception of the word "speed," which made the human foot a most unsatisfactory instrument of transportation, a slow and plodding creature, a sort of snail with brains. For up to the time of the invention of the locomotive and the motor-car, the foot, at best augmented by a pair of skates (originally consisting of a pair of bone runners, but afterwards made of steel) had been our sole standard of velocity and what it had accomplished was nothing to boast about. Now, in less than a hundred years, we had placed ourselves at the head of the procession. We may

not always know where we are going at such terrific speed, but, anyway, we are no longer sitting still.

And what was happening on the shore was soon afterwards duplicated on the water. Man is essentially a land animal, but he has been forced by hunger and by greed (and occasionally by curiosity) to spend a great deal of his time upon the water.

(The Foot)

SAILING ACROSS THE CHANNEL

And the different substitutes for the feet, which I have just enumerated, were of no earthly use to him when the shortest route from one point to another lay by way of a river or a brook. If the river were not too deep, he could wade through it or let his horse carry him across. But such a procedure inevitably meant the reloading of whatever cargo the traveler was transporting, and a lot of time was lost and it was felt that some method should be devised by which people could get from one shore to the other without being under the necessity of getting their feet wet.

(The Foot and Hand Combined)

THE ANCHOR

That is how bridges happened to be invented.

The first bridge was merely a dead tree that lay across a ravine and that was made passable by the flattening of the upper side. Trees, however, are necessarily limited in length, while rivers are not necessarily limited in width. Besides, horses and carts could not use these wobbly and narrow passageways and quite often wanderers slid down into the stream and were drowned.

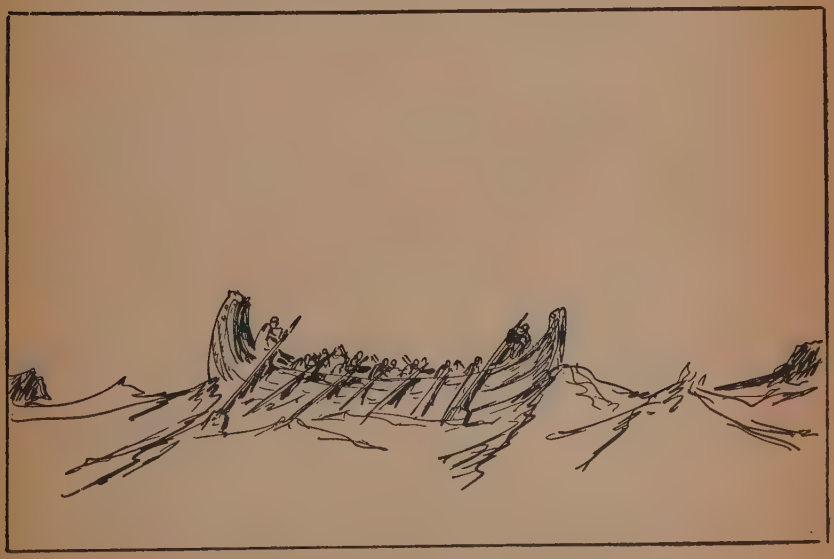
The Romans finally solved the difficulty. The Egyptian and Babylonian engineers had been quite as intelligent as their Roman successors, but they lived along the shores of rivers that were really small oceans and so wide that no one had ever dreamed of tackling them. Besides, those nations did not rule the greater part of the inhabited world and had no need of rapid and uninterrupted means of communication between one part of their empire and the next.

The Romans, on the other hand, administered hundreds of

thousands of square miles of territory and, having at their disposal only a limited number of soldiers, they were dependent upon their roads and their bridges to carry them from one end of their dominions to another with the least possible delay. The bridges they constructed were, therefore, most of them military bridges and not meant for commerce, and not until the latter half of the Middle Ages did the architects and the engineers begin to devote some attention to the ruins of the Roman structures and restore them according to the needs of the hour.

To-day with the ever increasing pressure of business, even the best intentioned of these suspended highways cannot always handle all the traffic that is being hastened from one city to another. Then the bridge (the foot) becomes a tunnel and dives underneath the bed of the river and reappears again on the other side with practically no interruption of the even flow of business.

So much for watery obstacles of a minor nature. But there



(The Foot and Hand Combined)

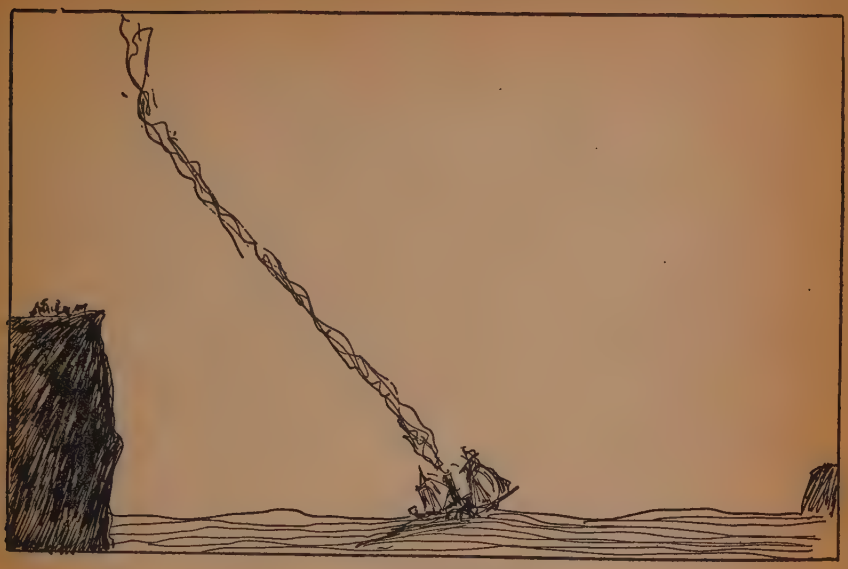
THE RUDDER

was the sea and the sea refused to let itself be conquered quite so easily and offered a much more difficult problem. One could of course imitate the fishes and the seals and swim, but the human body can stay in the water for so long and no longer. It was necessary to invent something entirely different to act as a foot-on-the-water. Animals overcome by a flood and riding to safety on the trunk of a dead tree may have suggested the idea of the first boat. But a log was a very unmanageable craft and it would upset at the slightest provocation. Therefore people dug a hollow space in the center with the help of a smoldering fire and stone scrapers and turned it into a regular ship which they propelled with the assistance of a long pole. And one day, after years of experiment, the prehistoric world was startled by the news that a man had crossed the English Channel in a boat. No doubt he was considered a much greater hero than Lindbergh, and in a way he was quite as important.

Then came the moment (one of the greatest moments in our

(The Foot)

THE STEAM BOAT



(The Foot)

CALAIS TO DOVER BY STEAM

history) when an intrepid sailor fastened the skin of a dead animal to a piece of wood, hoisted his cross beam to another piece of wood, planted his mast in the bow of his vessel and proudly let the wind blow him to his destination. When he finally crossed the English Channel in this ocean greyhound, I am sure that the people on both sides of that broad stretch of water felt convinced that the millennium was now close at hand and that it would be difficult to carry human ingenuity much further.

But it was only a beginning. For now the hand was coming to the assistance of the foot. The oar was invented. It made a deep impression. People looked at it and said that the ship was plowing its way across the sea. It made navigation a much safer business than it had ever been before. It relieved the sailors from anxiety about the winds. Provided one had enough slaves, one could predict with great nicety when one would arrive at a given spot.

And then out of the oar grew the rudder, which did not make its appearance until several thousand years after the invention of the first vessel. When rudders were introduced, ships still had the shape of square floating boxes and they were the same fore as aft. It was therefore necessary to have one rudder at the bow and another one at the stern. These rudders were nothing but enlarged oars and they were used in the same way as we

(The Foot)

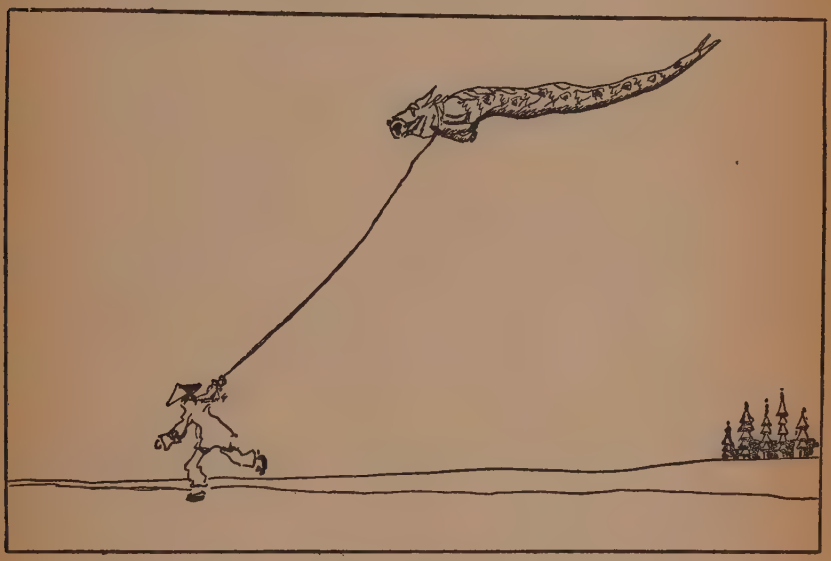
ENVYING THE BIRDS

use the paddles of a canoe. When ships began to increase their speed, and changed their general shape, the forward oar was omitted altogether and the rudder moved to the end of the stern, where it has remained ever since.

About the same time there was another change in the technique of navigation, due to a very simple device which came to be known as an "anchor"—a Greek word for a "hook."

The Greeks and Romans had hated the open sea as they had dreaded the snow-clad heights of the Alps and the Thracian

mountains. They were church-steeple sailors. When evening came, they simply hauled their vessels on shore and spent the night on dry land. This slow and costly method of peregrination was due to the fact that at night, when there were no stars by which they could set their course, it was impossible for them to lie still without drifting; and once they had started drifting, no one could foretell where they would end.



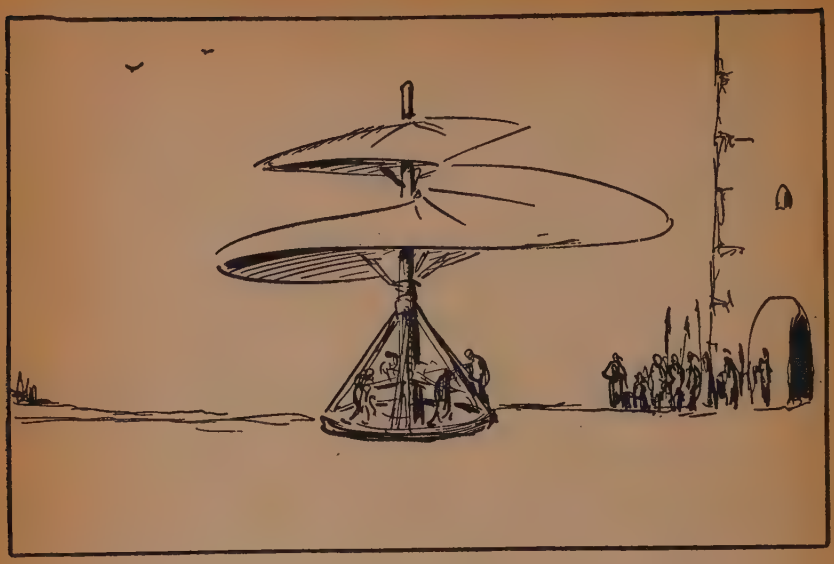
(The Foot)

THE KITE

The anchor, a heavy stone fastened to a rope, was really a hand which reached from the deck of the ship to the bottom of the sea and did away with this difficulty. It kept the craft in place and in that way made it possible for people to undertake longer voyages.

It was considered a most useful sort of multiplied hand and was adopted as a symbol of safety by more than one religious creed.

The sailors were now provided with everything they needed



(The Foot)

THE HEAVIER-THAN-AIR FLYING MACHINE

for their simple requirements. But in case of fog they were apt to lose their road and at night when there were no stars they were hopelessly at sea. This difficulty was overcome by the introduction of the compass, which made its appearance (Heaven knows whence) during the first half of the thirteenth century. Thereafter ships could venture forth into the uttermost corners of the Seven Seas and if their captains knew their business, and if their owners had not been too mean when they ordered the vessel to be built, and if the weather had been reasonably good, and the maps had been correct, those early barges often reached their destinations. For a sailing-ship or a galley, even in the hands of the most expert navigator, was still a comparatively helpless sort of creature.

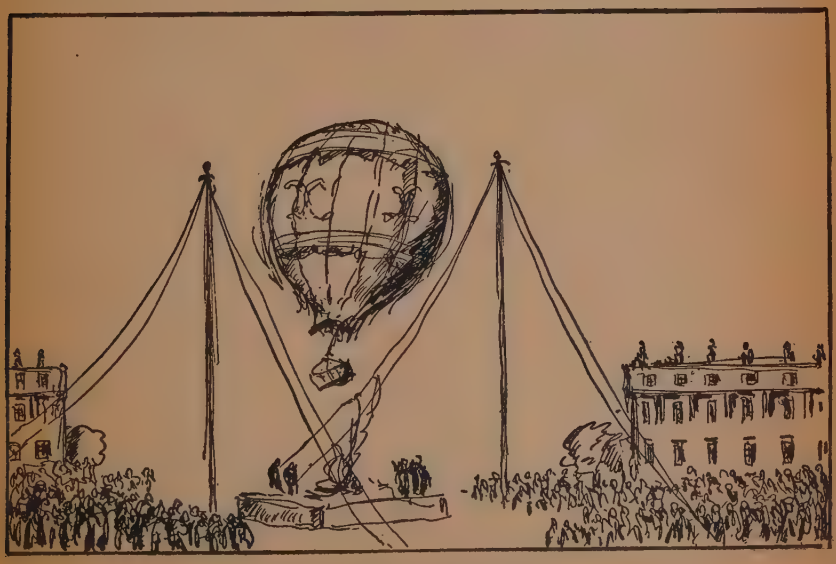
An adverse wind meant trouble.

A storm meant the loss of fully fifty per cent of all oars.

The whole problem of navigation, therefore, was reduced to

one single problem, how to make the floating foot independent of the wind and of the human hand.

Paddle wheels on both sides of the vessel, moved by human legs, were tried, but they were not a success. As soon, however, as James Watt had perfected his multiplied hand, a steam engine was placed inside the hold of the ship and was used to make the paddle wheels go round. Credit for this invention is usually given to Robert Fulton. But a number of people had been experimenting with "fire-boats" long before Fulton and that enthusiastic young painter was merely a very successful promoter of steam navigation. A dozen years after the end of the great Napoleonic wars, regular lines of steam-driven vessels plied between England and the Continent, and in the year 1838 America and Europe were connected by steamers which took two weeks for a voyage that in former times lasted anywhere from three weeks to three months.



(The Foot)

THE FIRST BALLOON

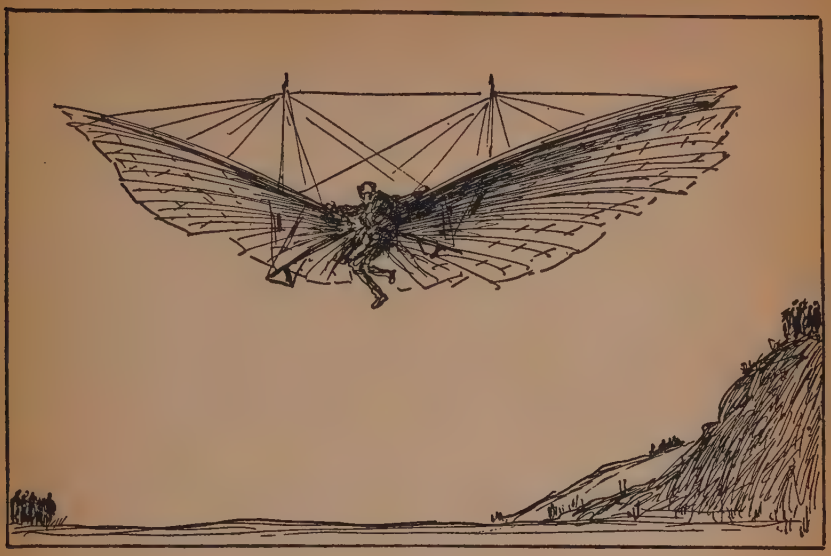
When the ocean racers were introduced some thirty years ago, the multiplied foot had annihilated distance on the waters as it had done on land. There remained only one domain to be conquered—the air.

From the beginning of time people had envied the birds. Their freedom of movement had filled their hearts with justifiable envy. The birds were independent of roads and bridges. Rivers and seas meant nothing to them. They had even solved the problem of cold and heat by migrating from North to South and from South to North with the changes of the seasons. Attempts to imitate the birds in one form or another, therefore, were almost as old as the human race itself and we find kites mentioned in Chinese histories of forty centuries ago.

But nothing shows quite so clearly how much man wanted to fly as the fact that in every mythology the gods are blessed with the gift of soaring through space.

(The Foot)

By Balloon to London



(The Foot)

THE GLIDER

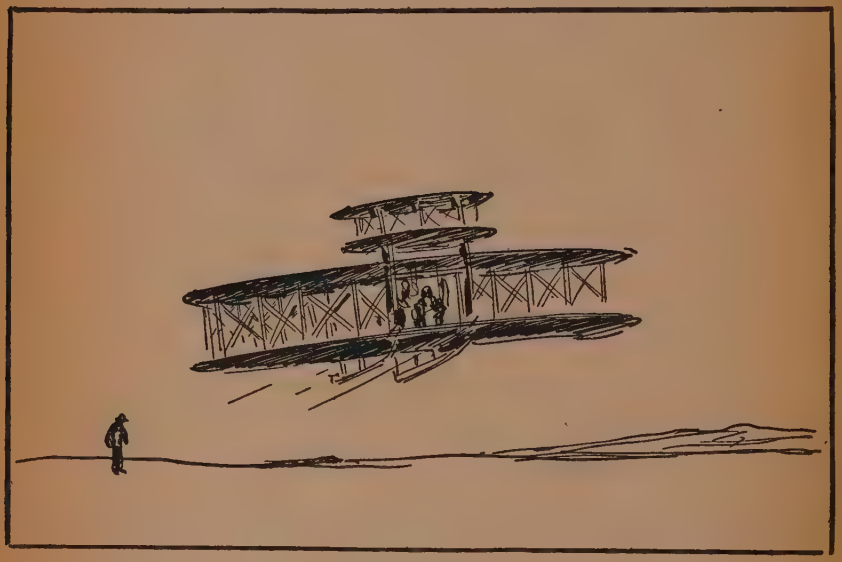
Nothing, however, was done in a practical way until late in the Middle Ages when the problem of substituting wings for feet was studied quite seriously by our old friend Leonardo da Vinci. He even went so far as to construct a number of flying-machines which worked beautifully on paper, but which invariably refused to leave the earth whenever they were exposed to a practical test.

Nowadays we know why Leonardo was bound to fail. There was nothing the matter with the body of his artificial birds. But the human hand was not strong enough to lift these overgrown kites from the ground. And nothing could be done until the hand should have acquired a thousand times more power than it had in the sixteenth century.

The problem, however, continued to interest people. During the latter half of the eighteenth century, a firm of French paper manufacturers buttoned together a number of sheets of tissue

paper, made them into a balloon, filled the thing with hot air and sent it up to the skies before a gaping multitude who promptly attacked the monster when it came down again and dispatched it with their pitchforks. But although man was now on his aërial way, he was unable to control the direction in which he was going.

With a favorable wind, he sometimes could use a balloon to travel from one country to another. He even crossed the English

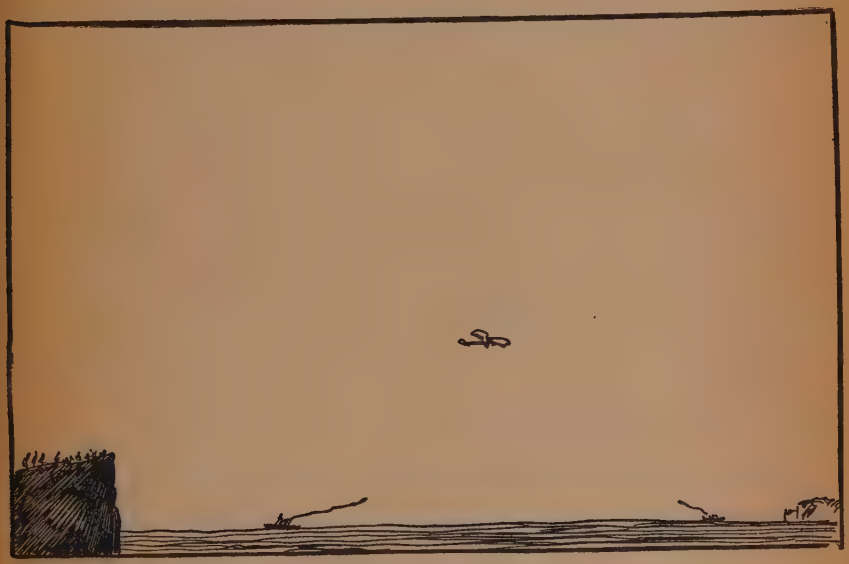


(The Foot)
THE FLYING-MACHINE

Channel. But once in France or Great Britain, he had no means at his disposal to return whence he had come.

The same was true of the soaring machines which were almost as old as the Chinese kites, but which were not made a subject of scientific investigation until about fifty years ago, when steam navigation and railroad trains seemed to have reached the end of their development and when there was another attack upon the skies.

The bird-shaped dinguses with which people began to slide through space in the seventies and the eighties of the last century could keep afloat for quite a long while, but a sudden gust of wind might cause their occupants to break their necks. Furthermore, it was hard to get them started and it was even more difficult to force them to land where one actually wanted to go. And wingèd man remained an idle dream until the manufacturers of those multiplied hands, known as motors, had reduced



(The Foot)

FLYING ACROSS THE SEA

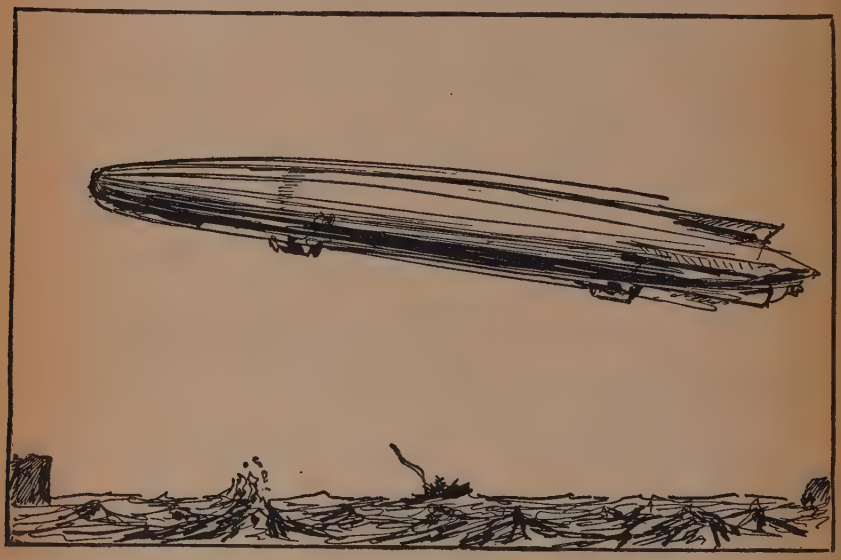
their product to such small proportions and had made them so reliable that they could be used without any risk of sudden collapse or an abrupt descent to the fields below.

The Wright brothers, so it seemed, were the first to fly. Their first journey lasted only fifty-nine seconds, but the thing had been done, and the rest was comparatively easy.

The inevitable cross-Channel voyage followed soon afterwards, and when Bleriot flew from Calais to Dover, the whole world

was convinced that now at last those old enemies of the human race, space and distance, had been successfully defeated and that the people of the earth, united into one glorious brotherhood, would forever after live in peace and harmony.

The purring propellers of the Zeppelins, crossing and re-crossing the same English Channel with their deadly cargo of dynamite and poison gas, once more warned us that the human foot, like the human hand, is an instrument that can be used



(The Foot)
THE DIRIGIBLE

for evil quite as much as for good and that the Road of Progress takes strange turns, many of which run through the cemetery.

As for the future of the multiplied foot, whether in a modified form, of which as yet we have no conception, it will ever allow us to escape from our planetary prison, that I indeed do not know. But it does not appear to be outside the limits of imminent possibilities. We may have to know a little more about the laws of gravity than we do at present; we may have to dis-

(The Foot)

THE LAW OF GRAVITY

cover a great many more things about our nearest stellar neighbors than we know at present; but when we realize in what miraculous way the power of the human hand and foot has been multiplied during only one short century, there is no reason why we should despair and feel that we are doomed to spend all of our days on one and the same speck of dust.

Remember one thing: we may seem to have traveled pretty far during the last five decades, but we are still terribly new at the business of using our brains. And few members of the human race have reached the point where they have the courage of their mathematical convictions.

But give them time.

(The Foot)

TOWARDS THE NEXT PLANET

CHAPTER V

The Thousandwise Varied Mouth

A SHIP bound for a foreign port takes its position at least once every twenty-four hours that it may know whether it is keeping to the right course. In the same way a writer who is trying to make headway across a part of the intellectual sea that has as yet been incompletely charted, must occasionally consult his compass lest he be thrown upon the rocks of rhetorical nonsense and perish miserably amidst the wreckage of his own eloquence. The compass, in my case, is the dictionary. The literary compass is not quite as dependable as its nautical sister, but like some sorts of time-tables, it is better than nothing at all. Behold what the "Britannica," in its bright and cheery way, has to say about the mouth:

"The mouth, in anatomy, is an oval cavity at the beginning of the alimentary canal in which the food is masticated. The opening is situated between the lips, and at rest its width reaches to the first premolar tooth on each side.

"The lips are fleshy folds, surrounding the opening of the mouth, and are formed, from without inward, by skin, superficial fascia, orbicularis oris muscle, submucous tissue, containing numerous labial glands about the size of a small pea, and mucous membrane. In the deeper part of each lip lies the coronary ar-

tery, while in the mid-line is a reflection of the mucous membrane on to the gum forming the frænum labii."

This shows me that I should have called this chapter "the vocal cords" rather than the mouth.

But vocal cords are a part of the human anatomy which rarely enters into polite conversation. The average person vaguely associates them with tonsilitis or colds, and in the popular mind (as is shown clearly by a number of proverbs and by Holy Script) the mouth is the instrument of speech rather than "an oval cavity at the beginning of the alimentary canal in which the food is masticated," as the encyclopædia so charmingly puts it.

Therefore when I use the word "mouth" I really mean "speech" and when I say that the greater part of the civilization of the human race is based upon the multiplied functions of the mouth, I am referring to man's gift of speech and to his ability to communicate his own thoughts to his neighbors by means of the greatest of all his manifold inventions—by means of a thoroughly developed system and thoroughly reliable system of highly differentiated sounds which go by the name of language.

I am not so rash as to imply that animals have no language of their own. There have been too many puppies and kittens in this house and too many swallows underneath the eaves of this roof to let me ever be guilty of such a dangerous piece of arrogance. Cats and dogs and horses and cows and birds and seals (and I suppose whales, though they are hard to keep in an aquarium and therefore a difficult object of study) are constantly telling each other things, and when they are bringing up their children, they become particularly loquacious.

But their language (as far as we know it, but I hasten to add that our information upon the subject is hopelessly restricted) seems limited to a brief code of warning signals, all of them intimately connected with the two overpowering passions

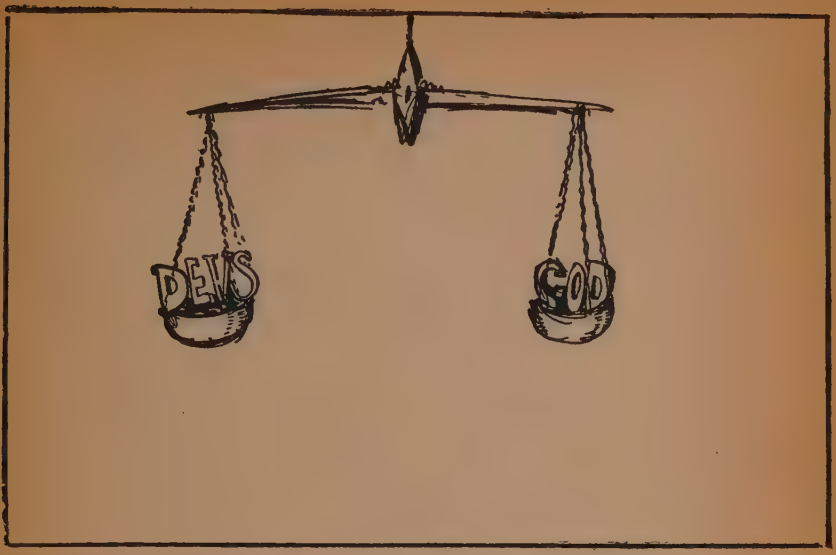
of their lives, the desire to perpetuate their own kind and their desire for food. Abstract ideas, which play such an important rôle in human relations, are entirely beyond their reach and even Hans, the mathematical horse, and Consul III, the learned ape, would be greatly puzzled if called upon to tell each other about the League of Nations or the relative merits of Christianity and Buddhism.

I shall be careful not to enter into a discussion of the origin of language. I don't know a thing about it. Not from any lack of available material, for there is any number of books upon the subject and they are brimful of the most learned details. But when they reach the main point of the discussion, they show in a most painful way that the mystery is still far from solved.

We know a lot about the development and growth of language.

The difficulty arises when we try to discuss at which precise point man ceased to be inarticulate and became articulate.

Problems like these make me wish that I could come back to this earth a couple of thousand years hence. We have learned such an incredible amount about ourselves in the few years that we have been able to devote to the subject, that undoubtedly some day within the next few centuries we shall be able to say: "Then and there, at that precise moment, Man ceased to grunt like an animal and began to speak like a human being." Meanwhile and in anticipation of that great moment, I gratefully register the fact that the mouth (read "the vocal cords") has done more for the development of the human race than any of the other organs, not excluding the highly useful hand and foot. For the mouth has given us a chance to pour all our accumulated knowledge into a form of permanency, and that means that every new generation becomes heir to all the wisdom accumulated by its ancestors.



(The Mouth)

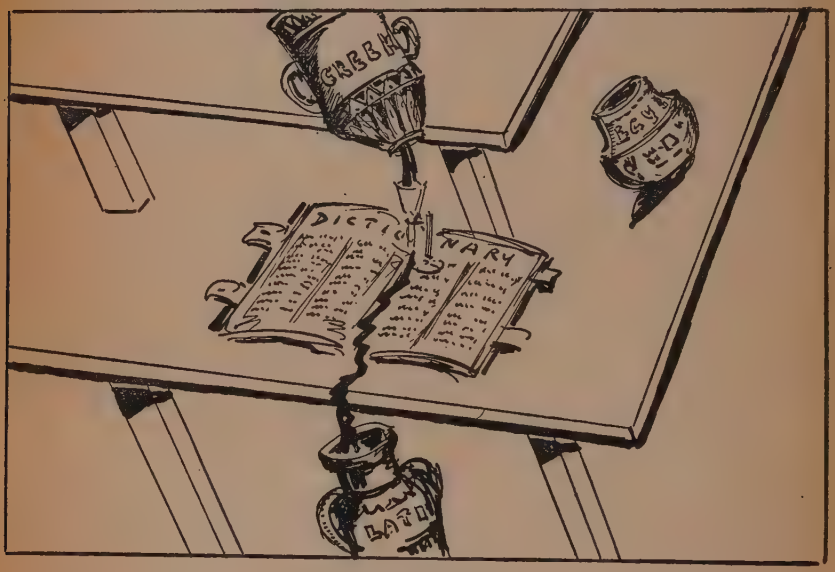
THE RELATIVE VALUE OF WORDS

The circumstance that the human race has apparently descended from a number of slightly varied ancestors, who did not possess a common form of expression (like those animals which belonged to the same basic group) may have accounted for the slow progress we made in the beginning. All this was changed as soon as some one discovered that every combination of groans and hisses in one dialect had an approximate counterpart among the combinations of groans and hisses of all other tongues, and that therefore it was possible to pour the contents of one language into the mold of another with practically no wastage of lost ideas and broken words.

Thanks to the art of the translator, Mankind has become one great intellectual brotherhood. I do not mean to say that all people everywhere avail themselves of this marvelous opportunity to improve their minds by borrowing the knowledge of their neighbors. The vast majority does not care about such

stuff. It wants to be decently fed, have a roof over its head, educate its children and go to an occasional movie but that is about all.

But those who do the real work of this world, whether they live in China or in Greenland, in Australia or even Poland, they are none of them obliged to base their conclusions upon their own observations alone. Even if they had never learned to read



(The Mouth)

THE ART OF TRANSLATING

and to write, even if the human race had never invented the alphabet, they could still learn what other people in other parts of the world had thought upon the subject by means of a good interpreter. And the poor savage who first suspected that words could be weighed against each other, as if they had been so much soap or cement or hay, stands revealed as the man who made the human race a unit in its warfare upon the gigantic forces of ignorance and fear.

Knowledge, however, is a luxury, while ordinary, plain living

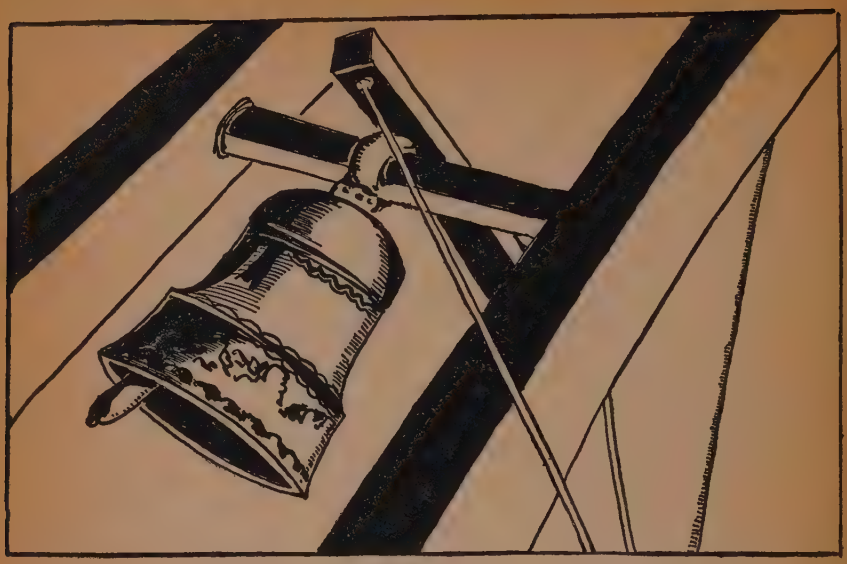
is a necessity. And the original purpose of the voice was to be an instrument of warning, rather than a means of instruction. An instrument of warning not only against those dangers that were visible but even more so against those that were not visible to the human eye and therefore infinitely more dangerous, since one could not take any precautions against them.

(The Mouth)

THE TOM-TOM

Remember that the less civilized a group of people happens to be, the more they believe themselves at the mercy of occult powers. Their lives are spent in fighting hidden enemies who lurk in the bushes and hide behind trees or at the bottom of wells, and whose sole purpose it is to frighten poor peasants, gobble up their children and cast spells upon their cattle.

The case would be quite hopeless but fortunately spooks are of a very timorous nature. It is possible to frighten them away by making a lot of noise. Shout as loudly as you can and no goblins will ever get you.



(The Mouth)
THE BELLS

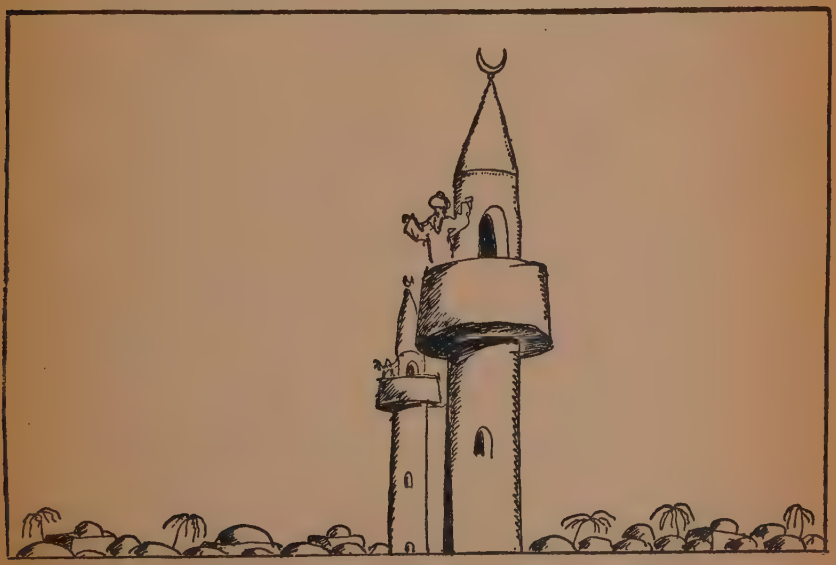
Shouting, however, is very tiresome work and bad for the vocal cords. And so at a very early date the human voice was replaced by a hollow piece of wood which acted as a substitute for the mouth and in booming tones told all the wicked specters to take warning and be gone.

Under ordinary circumstances a short tattoo upon a drum would put the fear of God into the little devils, but when they were very persistent (which happened in the spring and in the summer) it was necessary to drive them away by beating the tom-tom for days or weeks at a stretch.

How profoundly this habit of frightening away the bogies with the help of noise entered into the social system of the human race was shown by the tremendous popularity which the ringing of bells acquired during the Middle Ages. The church bell, a metal mouth and nothing else, was kept reverberating morning, noon and night. Gradually its original purpose was forgotten

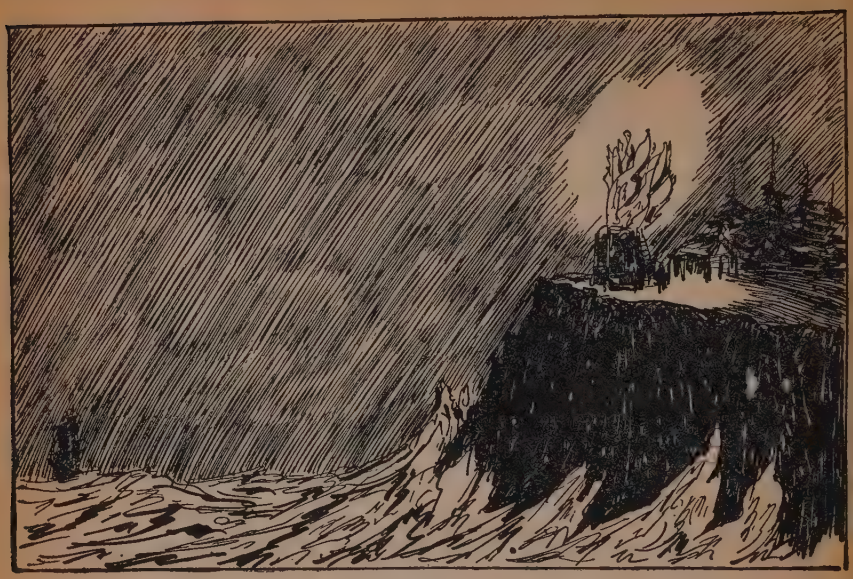
and it was used for a number of other purposes. It announced the time of day and told the serf when it was time to get up and when it was time to go to bed. But it never quite lost its original character, and on Sundays and holidays a prolonged ringing of the bells warns the faithful that they should come to church and incidentally it purges the atmosphere of those unclean influences which might have a detrimental effect upon the proper conduct of divine services.

The Mohammedans, for some strange reason, have never taken kindly to bells. They have remained faithful to the human voice and employ human beings who climb to the galleries of specially built towers and from there enlighten the world about the great virtues of Allah and the not less remarkable accomplishments of his chief prophet, Mahommed. In how far these officials could make themselves useful as fire-gongs and cyclone sirens, that I do not know. But fortunately these are items



(The Mouth)

THE CALL TO PRAYER



(The Mouth)

THE ANCIENT LIGHTHOUSE

about which the average follower of the half-moon is not apt to worry overmuch.

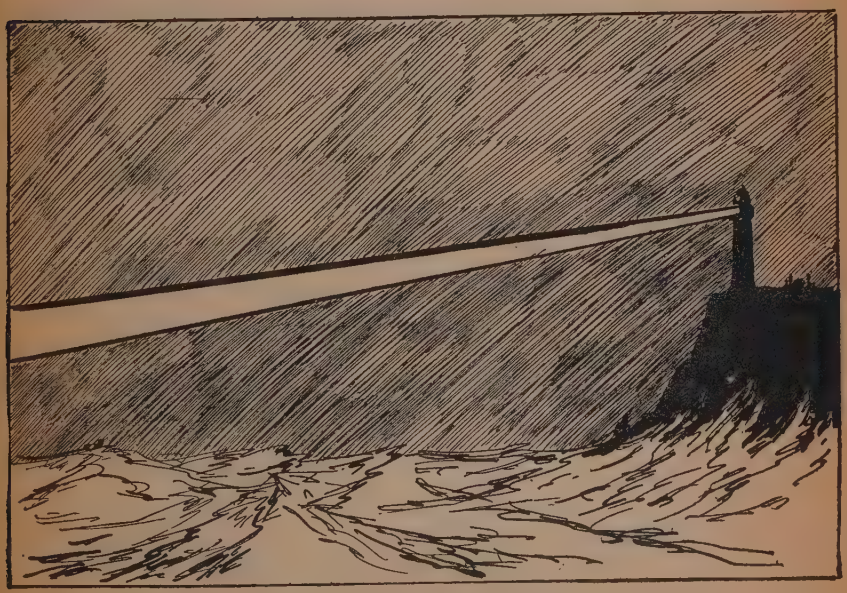
. . . . . .

In Europe, however, where government more and more occupied itself with the common weal (a matter to which the Mohammedan rulers were as a rule blissfully indifferent) the mouth was used for a large variety of purposes all of which were directly connected with the business of either telling people what they ought to do or warning them away from what they ought not to do.

I do not merely refer to the horn with which the mediæval town guard tooted his little tune to tell the good burghers that all was well with the world and to remind them that they must be careful of their fires. I am thinking of several more ambitious purposes for which the augmented voice was used in bygone days.

There was the problem of navigating the seas at night. As long as one was far away from the coast it was plain sailing. The chances of collision were small and the shallow vessels of that time were not afraid of an occasional sandbank. But when the ship approached land after sundown, then the difficulties began. It would, of course, have been possible for the Romans and the Greeks to put a slave with a fine baritone on every promontory and let him shout words of warning to the approaching mariners. But it is doubtful whether there were enough slaves with enough good baritone voices to keep all craft from harm's way. Something else had to be devised to act as a substitute for the human mouth. The difficulty was solved by having wood fires on the tops of the more dangerous ledges. The lighthouse made its appearance as a modified voice.

The general esteem in which such towers-of-warning were



(The Mouth)
THE MODERN LIGHTHOUSE

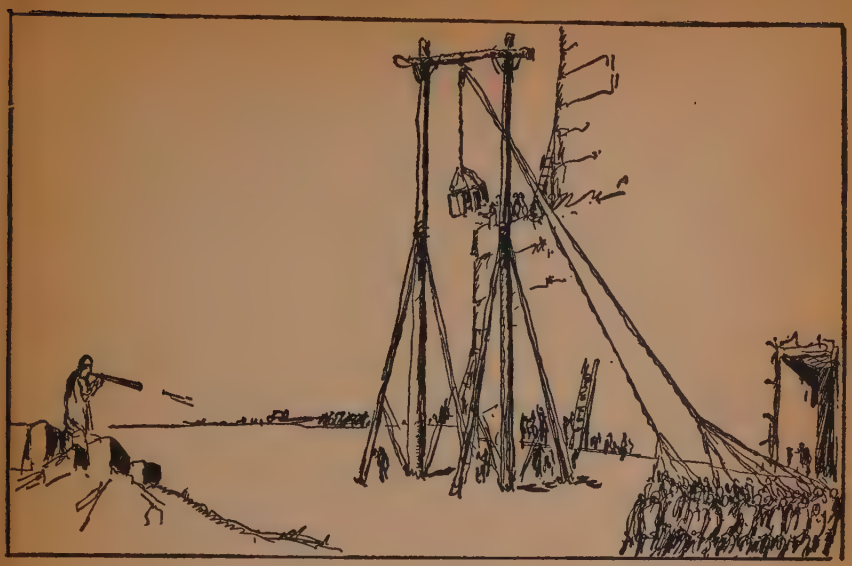
held we learn from the fact that the ancients honored the lighthouse of Alexandria (built 300 years before the birth of Christ) by giving it honorable mention among the seven wonders of the world. Incidentally, the architect who built it must have known his business, for the famous Pharos shed its rays upon the seas for more than sixteen centuries and it was then destroyed only by an earthquake.

The Romans (I hardly need say it) were great lighthouse keepers. Only let them construct something that had to do with roads and harbors and traffic regulations, and they would spend millions upon it and improve it until it was well-nigh perfect. All along the coast of Europe they built their warning signals. Dover and Calais had their lighthouses long before our own ancestors had ever heard of a lamp, let alone a tower.

During the Middle Ages the lighthouse system came to a temporary end. The buildings, wherever they had not fallen

(The Mouth)

THE FOG HORN



(The Mouth)

THE MEGAPHONE

to ruin, were fixed up as churches and the shores were left in darkness. But with the return of commerce, the signal towers once more became an everyday necessity. At first coal was substituted for wood as a means of illumination. Then came gas and oil. To-day electricity acts as a substitute for the mouth and silently shouts its warning words as far as thirty miles away.

Lighthouses, unfortunately, could function only on clear nights. Whenever there was fog, they were useless. On such occasions light had to be replaced by sound. At first it was enough to ring a bell. But the bell did not carry far enough for modern sea traffic. The foghorn, a tremendously amplified voice operated by steam, was then given a chance until the invention of wireless telegraphy.

Since then a quietly whispering voice tells the mariner of his danger, and within a very few years, both lighthouses and

foghorns will have become as obsolete as the fire-gong. For the modern mouth likes to work discreetly. It tries to be efficient but in a quiet and dignified way. Like all human devices, it can be terribly abused as those of us know whose neighbors are possessed of portable phonographs. But given half a chance, the mouth will behave with great decorum, as you will know if you

(The Mouth)
SMOKE SIGNALS

have ever listened to those other multiplications of the power of the mouth known as "far-speakers" and "far-writers."

At first whenever one man wished to communicate something of importance to some one else, he could do this by means of his voice or by means of his hands. The sign language, however, was soon disregarded for the sound language. To-day it survives only among the deaf and dumb, but otherwise has become completely extinct or is used to accentuate the spoken word. The method of communicating by means of sound, on the other

hand, has taken a tremendous development and its history is very interesting.

Already on the oldest Babylonian sculptures we find pictures of rudimentary "far-speakers." We see engineers bossing a hoisting job. A thousand slaves are pulling the ropes. The engineer stands on a little platform. He carries a megaphone

(The Mouth)

DRUM SIGNALS

in his hand. The megaphone is, of course, a magnified mouth. Through this megaphone he shouts "Heave ho!" and all the slaves pull at the same moment. Without the magnified mouth, the engineer's voice would not carry to so many people at the same time. It is the first attempt to multiply the power of the voice an unlimited number of times. It is the beginning of those endless future experiments which eventually led to the telegraph, the telephone, wireless and radio.

There are certain inventions which attracted very little attention on the part of the public when they were first made. The

(The Mouth)
CARRIER PIGEONS

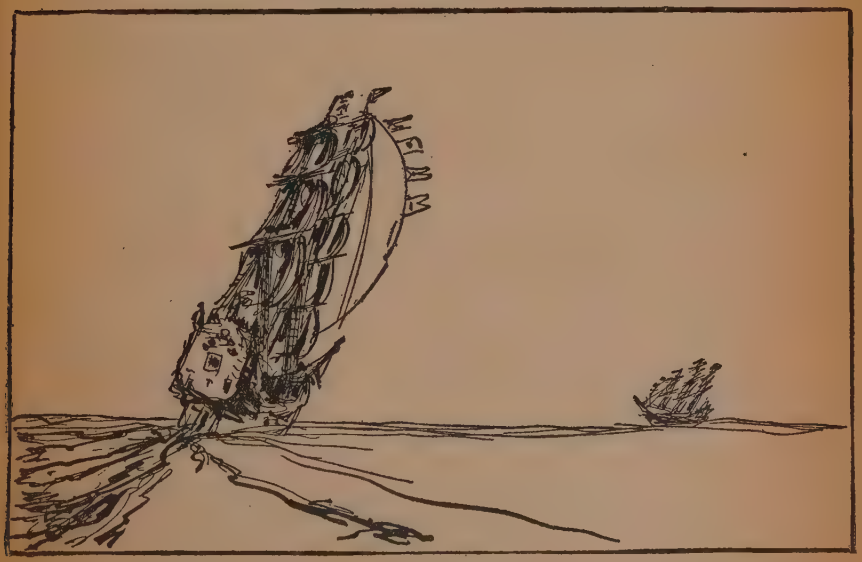
reason was that they did not enter into the daily lives of enough people. But everybody has at one moment during his career felt himself handicapped by the fact that the voice would not carry for more than a couple of hundred feet and everybody, therefore, was interested in the attempts that were being made to overcome this difficulty. As a result we can follow the development of the "far-speaker" throughout the ages much better than that of the multiplications of most other human organs.

If tradition is right (and tradition is often much more reliable than history based upon documentary evidence), the news of the surrender of Troy was telegraphed to Greece by means of smoke signals. In Africa since time immemorial the different tribes have communicated with each other by means of gigantic drums which were belabored with a stick, and thus spelled out messages which were as clearly understandable to the natives of

the Congo as the Morse Code is to the employees in a Western Union office.

During the Middle Ages when the more civilized part of humanity lived in small, high-walled cities, like wild animals cooped up in a cage, pigeons were used to carry messages whenever the town in question was being beleaguered by an enemy. On the ocean, whenever the weather was sufficiently clear, information was forwarded to passing vessels by means of signal flags.

These clumsy methods of magnifying the human voice were quite sufficient for the needs of small communities. But when states kept growing larger and larger and became more and more centralized, no government could expect to survive for very long unless it could make its voice heard in every part of its domains at one and the same moment. Couriers, drums, carrier pigeons were of little use during a crisis and the life of every big modern nation is one endless succession of crises.



(The Mouth)
FLAG SIGNALS

In consequence thereof the eighteenth century, the age of consolidation of vast dynastic and racial groups, also became the era of wholesale telegraphic experiments.

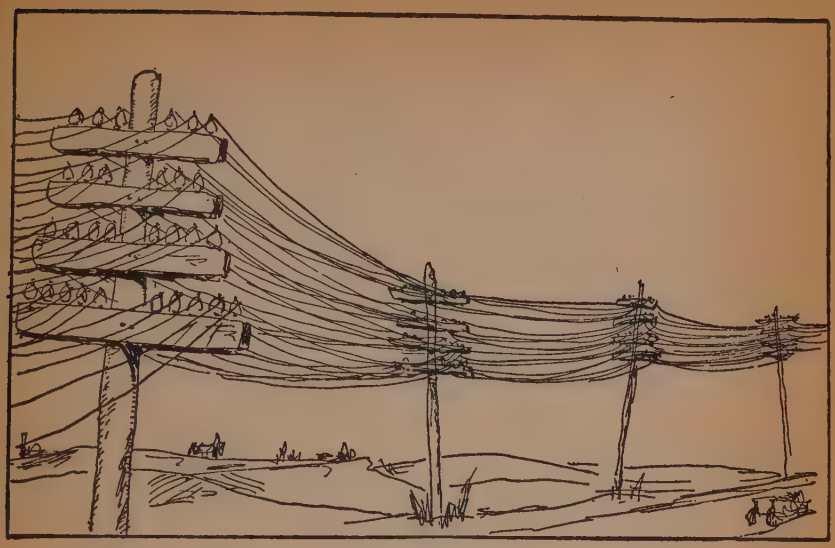
Since the French were the first to centralize their government, they quite naturally became the pioneers in the field of long-distance transmission for the human voice.

In the spring of the year 1792 an engineer by the name of Chappe approached the National Convention with a fully worked out plan for an "optical telegraph"—a machine that was to be worked from the tops of conveniently located church towers and hills and which consisted of a couple of wooden arms, fastened to a transverse bar. The position of the arms, which could be changed by means of ropes and pulleys, spelled out the letters, and officials with spy glasses read the messages and relayed them to the next towers, and so on and so forth, until the words had been duly carried from one town to another.

The thing worked remarkably well and during the Napo-

(The Mouth)

THE SIGNAL TOWERS



(The Mouth)

THE TELEGRAPH

leonic era the greater part of Europe listened to the dreaded imperial voice by means of M. Chappe's semaphore.

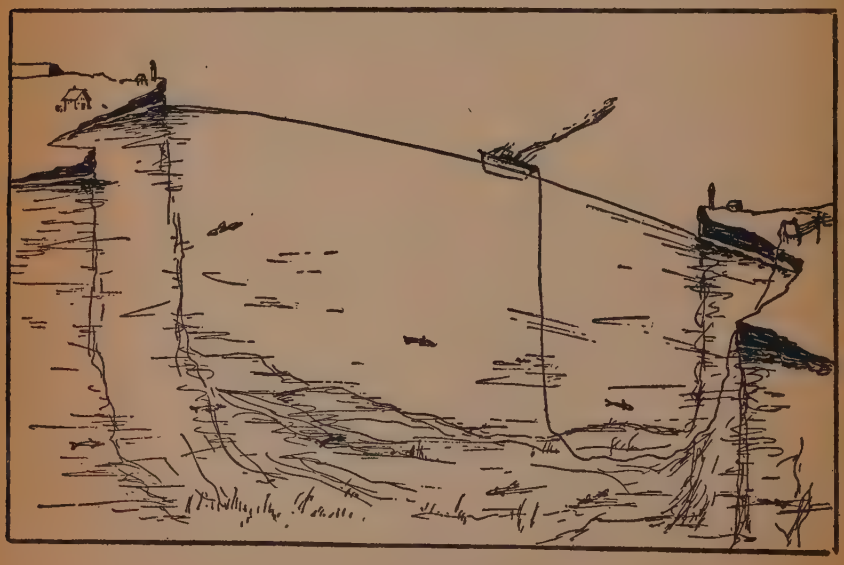
It suffered, however, from one great disadvantage. It was impossible to keep the messages secret. The town loafers used to congregate around the church towers and puzzle over the different signs until they were able to read the alphabet as easily and as fast as the operators themselves. That made it necessary to look for some other way of conveying information that should not be quite so public.

But just when the semaphore was giving up the ghost, the world had begun to play with a charming new toy, called electricity. In every town and hamlet some obscure village genius was trying his luck with this mysterious current, in the hope of making himself rich by finding some way to make it carry communications from one place to another. In every German laboratory a solemn professor was wasting his wife's last pennies

upon batteries and pieces of copper wire, that he might be the first to give the world its common voice.

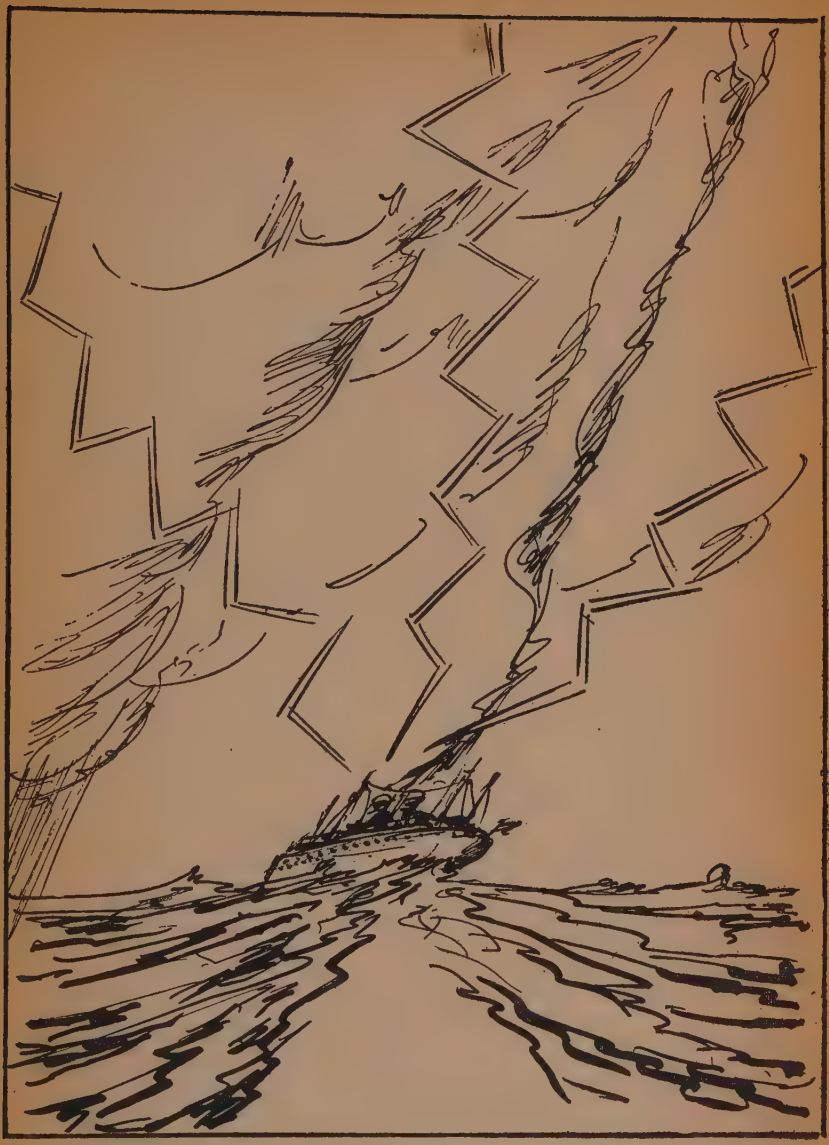
An American painter by the name of Samuel Morse won the race. In the year 1837 he converted his easel into a telegraphic apparatus. This first machine could talk at a distance of 1,700 feet. A year later he felt that he had progressed far enough to bring his invention to the notice of Congress. But Congress was busy with something or other and did not listen to him until half a dozen years later. At last, in the year 1844, Washington and Baltimore talked to each other by means of an electric current.

Then the different European governments, which had been absolutely indifferent to Morse's plans as long as they were in the experimental stage, began to show signs of interest and to-day the human voice, reduced to dots and dashes, penetrates to every part of the civilized world. For the telegraphic wires soon bade farewell to dry land and took to the water. As soon as ships



(The Mouth)

THE TELEGRAPHIC CABLE



(The Mouth)

WIRELESS TELEGRAPHY

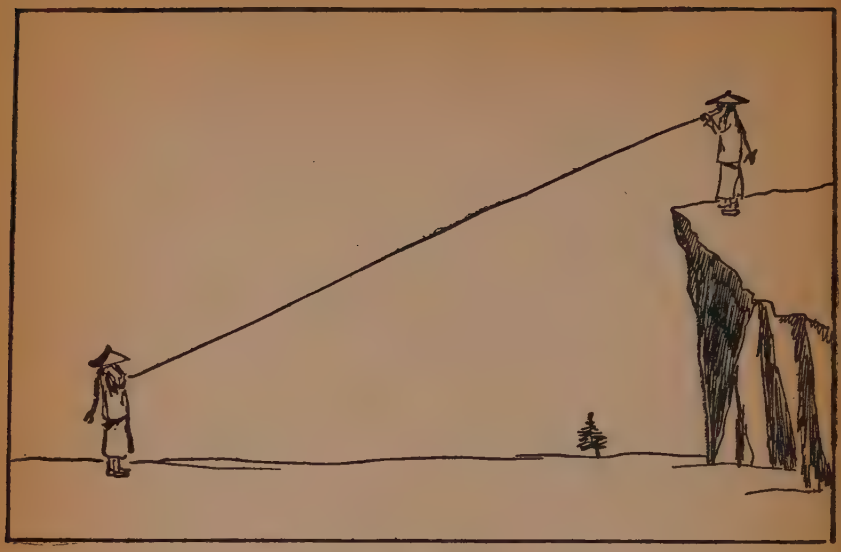
had been constructed big enough to lay 3,000 miles of cable, the wires were stretched across the bottom of the ocean and the people of New York found themselves living in a suburb of London, and vice versa.

For quite a long time the electric telegraph was able to satisfy all the needs of verbal international intercourse. But as our planet continued to shrink more and more under the influence of the multiplied hands and the multiplied feet, there arose a demand for something that should not be quite so dependent upon the presence of the very expensive cables that were an integral art of Samuel Morse's invention.

The notion of speaking from one town to another without the assistance of any intervening wire was an old one. As early as the year 1795 a Spanish physicist by the name of Salva had explained the feasibility of such an arrangement to the Academy of Science of Barcelona. The Academy had listened patiently, as learned Academies are apt to do, and then had forgotten all about it.

A generation later, a German, quite independent of his Spanish colleague, had tried to establish wireless communication by forcing his electric current to pass through water. The trouble in those days was that no one knew the exact nature of the material with which he was playing his little game. It was left for Heinrich Hertz, one of the most brilliant scientific detectives of all times (and so ardent a worker that he investigated himself into an early grave), to show us a way out. He did not reach the point at which he could tell us what electric waves really were, but he discovered the laws which regulate their behavior, and that in itself was an enormous gain. After the publication of Hertz's work, the problem of wireless telegraphy was taken up in all seriousness and every nation tried to be the first to bring the search to a successful conclusion.

A young Italian by the name of Marconi managed to get a



(The Mouth)
THE CHINESE TOY

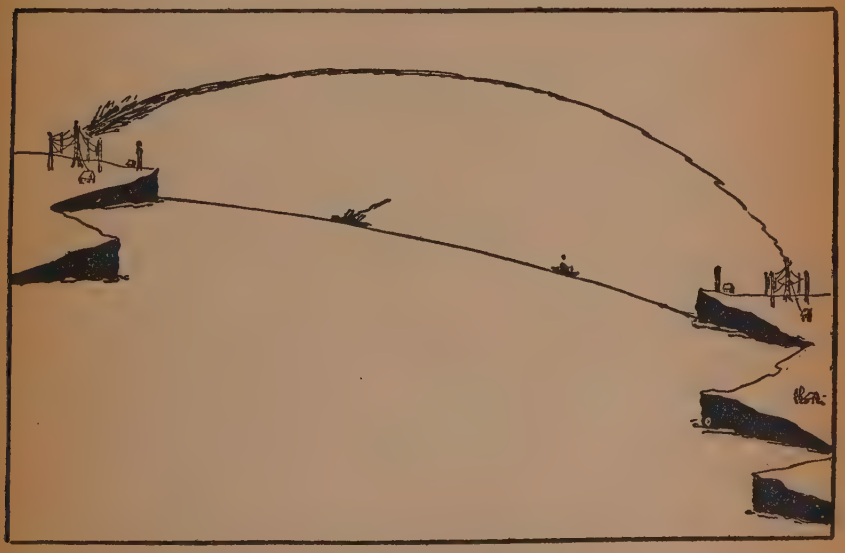
single wireless letter across the ocean. The other members of the alphabet followed in rapid succession. To-day even the ship's captain, who for thousands of years has been the most independent of citizens, is obliged to listen to his master's voice no matter how far he may be away from land. And an airplane lost in the clouds is still in touch with the earth and can be warned of an approaching storm as easily as if it were within hailing distance of the human voice.

But the appetite, as the French proverb has it, comes with the eating. As soon as the art of "long-distance writing" had become an established fact, people were no longer contented with their little plaything and began to clamor for a machine that should allow them to indulge in the unknown luxury of "long-distance speaking."

Thousands of years before, the Chinese had invented a toy which consisted of two bamboo tubes connected by a thin wire,

which made it possible for people to converse with each other over a distance of several hundred yards. It was one of those perennial trifles that return regularly every two or three generations, are advertised all over the place as "the latest novelty," are hawked from every street corner, and disappear once more as inexplicably as they have come. The people of the Middle Ages played with it and so did those of the eighteenth century. And just when everybody was talking about the great possibilities of the electric current, the old Chinese thingamajig popped up for the fiftieth or hundredth time and was being sold widely at all county fairs.

It seems to have inspired several people with the notion that this might be the way to carry the human voice from one spot to another. A Teuton by the name of Philipp Reiss was the first to perfect such an instrument of "sound transmission." It worked so well that he dared give it the ambitious name of



(The Mouth)

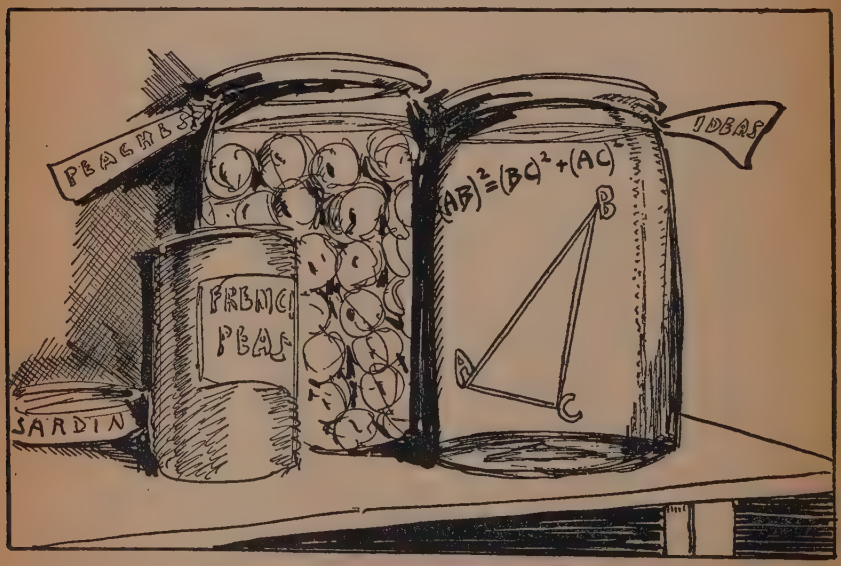
RADIO

"telephone," the apparatus-that-carried-the-sound-of-the-human-voice-across-space.

Fifteen years later a Scotch immigrant by the name of Alexander Graham Bell, who lived in Boston and was a teacher in a school for the deaf and dumb, solved the problem of sound transmission by giving us the modern telephone with which all of us are familiar.

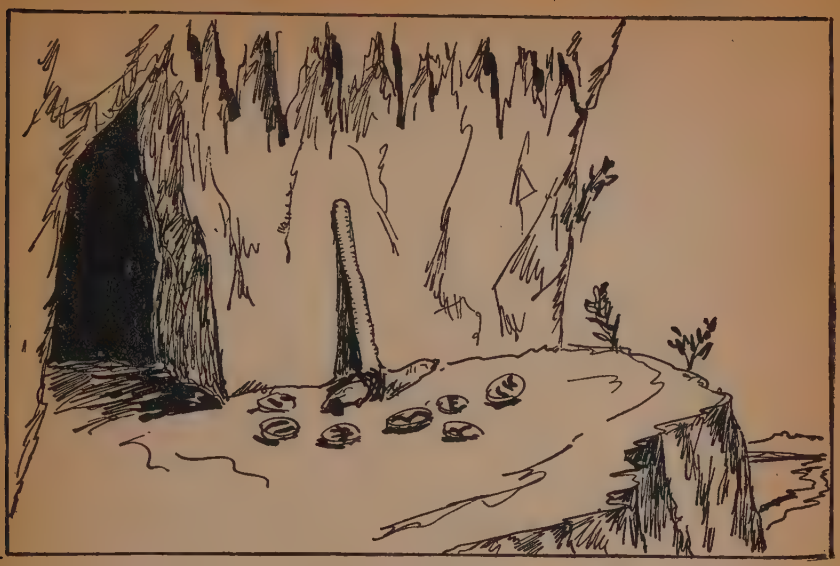
How the voice which depended upon a wire for its transmission grew into the voice which could project itself without any wires whatsoever, that is a story of such recent date (and to the present author of such incomprehensible mystery) that I shall give you a picture and let it go at that.

But to-day it would be possible to destroy every book that was ever written and still keep the human family fully informed of everything that was being done and thought and said everywhere by use of the multiplied mouth. For all we know, even the long-suffering citizens of Mars and Saturn may be listening



(The Mouth)

PRESERVING PEACHES AND IDEAS



(The Mouth)

THE MYSTERIOUS PEBBLES

in when the raspberry experts of our great Republic tell the good people of the northern hemisphere how to make their preserves without burning the sugar.

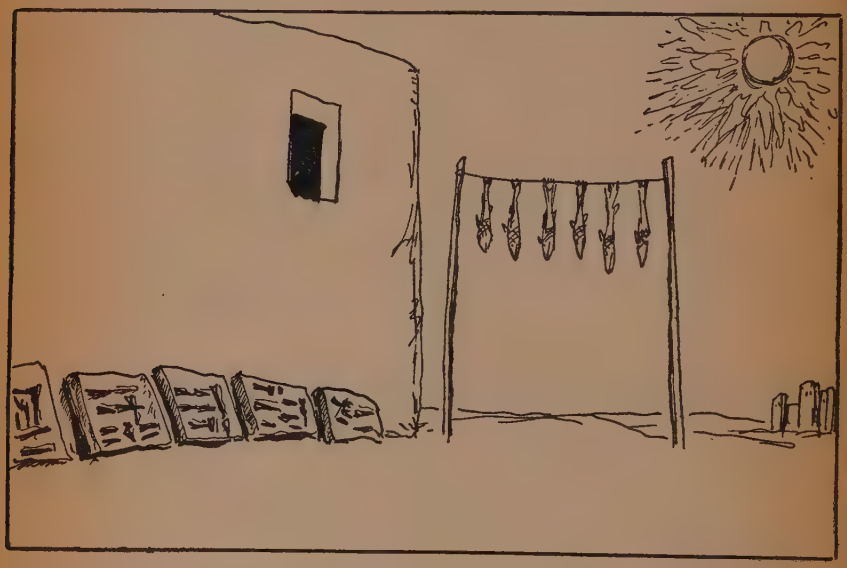
Which brings me to the most important part of this book, which I have kept to the last, partly because it is more important than anything else I have said and partly because it is so hard to explain in sentences of not more than fifty words each.

Granted that it is almost impossible to decide at what precise moment in their history our ancestors acquired the ability to speak, it is even more difficult to follow the process by which they arrived at the conclusion that the spoken word could be conserved and that the sounds which left the lips could be caught and kept in a permanent form for the benefit of posterity.

The age in which we live will be known as the Paper Age. We wallow in the printed word. Without books, without time-tables, order-blanks, telegraph-blanks, telephone directories,

newspapers, magazines, without myriads of little pieces of dried-out wood-pulp covered with funny little black pot-hooks and semi-circles our modern civilization would soon come to an end.

It is practically impossible for a citizen of the year 1928 to think himself back into a paperless age. And yet, if we represent the length of time that man has lived upon this earth by a period of twelve hours (running from midnight to noon), the art



(The Mouth)

DRYING FISH AND DRYING THOUGHTS

of putting ideas into the concrete form of the written word was invented no longer than nine or ten minutes ago.

But how it was invented and by whom and where and under what circumstances—all that still remains a mystery and will continue to be so until we shall have learned a great deal more about the civilization of our earliest forefathers than we know to-day. Could they write or couldn't they, and if they could write, what was the meaning of those strangely colored pebbles

which we have found among the bones of their graveyards and in their caves?

The answer is that we do not know.

Almost every year we are told that now at last Professor So-and-So has succeeded in finding the key to this exasperating mystery. Then there is great rejoicing in the land of the learned, for now at last the history of the human race has been carried back another 10,000 or 15,000 years. But ere long there is doubt. Finally a careful examination of all the pros and cons shows us that there was nothing to the latest hypothesis and that we must begin all over again.

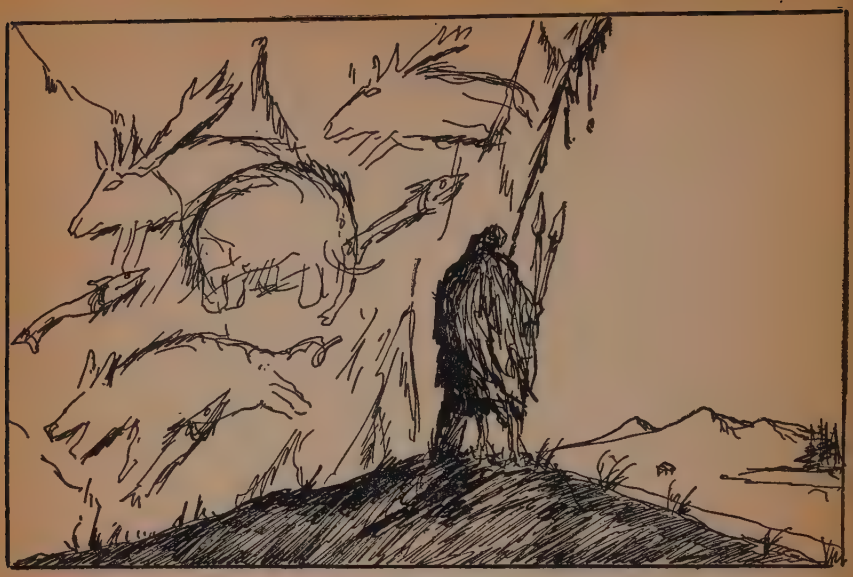
Of course, the people of the Middle Ages felt the same way about the hieroglyphics and the clay tablets of the Babylonians. Then came Thomas Young, Champollion and Rawlinson and to-day those who have learned the art can read cuneiform and ancient Egyptian as they can read their daily newspapers.

I have no doubt that some day the riddle will be solved. It may happen next year. It may come a hundred years from now. We don't know and so for the moment we are obliged to guess or say nothing at all.

We know from the researches made in the old caves of Spain and France that man began to draw pictures almost as soon as he began to make tools. Some of those pictures showed such great technical perfection that the archæologists who reported their discovery were accused of having faked the whole gallery of mastodons and fishes and deer for the sake of gaining a little notoriety. Nowadays we know that these pictures were genuine and that we may expect to discover more and more of them as time goes by.

But what did they mean to the people who made them, and were they connected with a conscious attempt at putting abstract ideas into a concrete and imperishable form?

Most probably not.



(The Mouth)

NECROMANCY

They had to do with magic—with necromancy. People drew pictures of wild boars and elephants before they started out to hunt those creatures in the hope that they would be able to cast a spell over them and get hold of them with less effort, just as the potentates of the Middle Ages would make wax figures resembling their enemies and would then stick them full of pins.

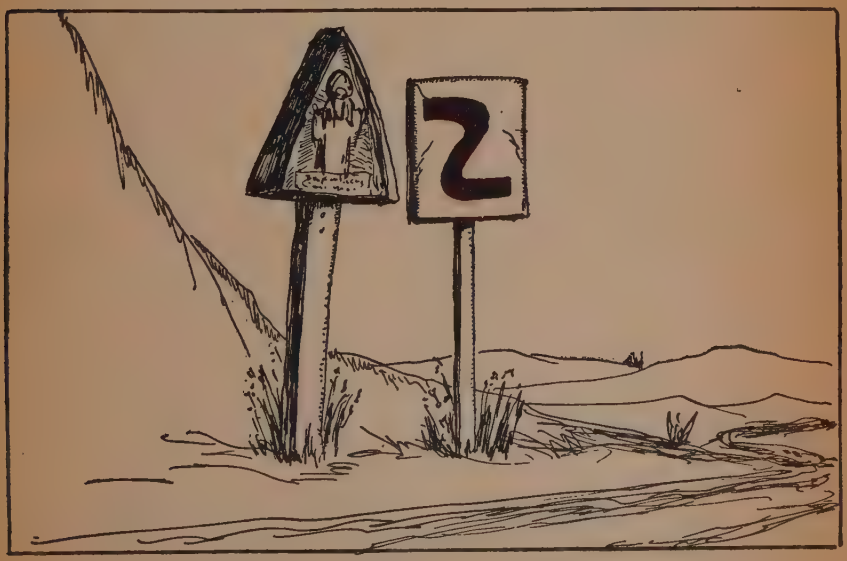
Those prehistoric drawings therefore are not the remnants of an early form of picture language. They are expressions of the religious spirit of that day. They tell a story (as all pictures do) but they are not connected with man's desire to conserve his ideas in a concrete form.

Which brings us face to face with the next question: when did pictures cease to be mere pictures and when did they become part of a definite system of thought preservation?

A modern example will show you how difficult it is to draw the exact line between the two forms of pictorial expression. In

Europe, by the side of many mountain roads, you will find small painted signs which have been erected for the purpose of giving the passer-by a concrete piece of abbreviated information. One of these two signs shows us the portrait of a saint. A wanderer (dead and buried these last five hundred years ago) was caught on this spot by a hurricane and the good saint saved his life. The grateful patient thought the event so important that he had a picture painted to tell all passers-by what happened during this supreme moment in his life. The second sign is merely an inverted letter S which has been erected by the local automobile club. Its meaning is clear to all those who drive cars. That inverted S shouts in unmistakable tones: "Be careful! You are fast approaching a dangerous curve."

Both pictures tell a story. But one belongs to the sort of images out of which a written language was eventually developed.



(The Mouth)

THE DANGER SIGNAL SPEAKS

How that happened I shall try to tell you with the help of another sketch.

Take this message of a hunter of the glacial period, scratched upon the sides of an overhanging rock. He has strayed away from his companions and suddenly he sees two deer away off in the distance. He wants to follow his quarry but is too far away from the others to tell them so by word of mouth. He cannot reach them with his voice to say: "Hey there, listen! I have gone after two deer." He must find another way. So he draws a rude picture on the rock and this picture is really a letter which reads: "I have seen two deer near the lake and I am giving chase. Don't wait for me. I will come back."

If the Bushmen (who were splendid artists and who have left us many pictures of this sort) had had occasion to send messages like that often enough, they might finally have developed a picture language in which every sign would have stood for a definite word which thus far had existed only in the spoken form. But

(The Mouth)
THE FIRST LETTER

(The Mouth)
THE ROPE RECORD

mark the qualifying words of the last sentence: "If they had had occasion to send messages like that *often enough!*"

It was necessary for the same drawings to be repeated endlessly before any one would have hit upon the idea that such images could be used for the purpose of preserving the spoken word in a concrete pictorial form, and among a very simple people that was something that was not at all likely to occur. And so it happened that quite a number of primitive tribes came within an ace of inventing a written language and yet failed for lack of sufficient opportunity to study the problem. In their anxiety, they tried a number of schemes. On the American continent the Peruvian Indians developed a system of keeping tab on national affairs by means of little bits of colored string in which they made knots that had a definite meaning. The Chinese, who had time to do things thoroughly, worked out a complicated method consisting of tens of thousands of little pictures, each one of

which represented a word or an entire idea. This was a step in the right direction, but it forced the intellectuals of that interesting nation to learn thirty or forty thousand small images by heart before they could say, "Yes, I can read and write a little."

In short, the whole world was eagerly looking for a handy method to conserve the spoken word and no one was successful until the Egyptians appeared upon the scene. Whether the

(The Mouth)

THE HOLY SCRIPT OF EGYPT

Egyptians had got their first hint of the possibility of such a thing from some other people of whom we have lost all track, that again it is impossible to tell.

Until we shall have gathered a little more concrete information about the mythical continent in the Atlantic which is mentioned in so many ancient books, credit for the first workable system of picture writing should undoubtedly go to the subjects of the Pharaohs. But with them, writing remained what it had been in the beginning, a holy art to be practiced only by the

initiated, by the priests. In the course of time a simpler form of picture writing grew up next to the officially recognized hieroglyphics. But for commercial and everyday purposes even this popular form of image writing was a little too complicated. It was not easy to learn them by heart and we might have been obliged to wait Heaven knows how long for our alphabet if it had not been for the Phœnicians.

That those highway robbers who cared less than nothing for the arts should have given us one of the most useful inventions of all times may well seem one of those grim jokes of which history is so fond. But there is a perfectly good reason why they and not the Egyptians or the Babylonians should have been the first to think of this practical solution of the problem.

The Phœnicians were business men. They needed a short and handy system of taking down agreements and contracts. They were obliged to send business letters to their representatives in the different settlements along the shores of the Mediterranean

(The Mouth)

THE PRACTICAL SCRIPT OF PHŒNICIA

(The Mouth)
RUNIC WRITING

and could not waste time making pretty water-colors when they were talking of olive oil and Samothracian goatskins. And, being professional robbers, they borrowed some of the holy little pictures from their Egyptian customers, clipped them into short, stenographic symbols, added a few signs of their own making, stole a few others from those neighbors who were working upon the same problem and worked these lines and dots and pot-hooks into a system of speech-preservation which enabled them to catch practically every sound that escaped from the human mouth and put it down in a concrete and visible form for the future benefit of themselves and their descendants.

How this alphabet traveled from Phœnicia to Greece, how the Romans remodeled these letters so that they could be engraved over the doors of their temples and around their triumphal arches, how the German tribes changed them in such a way that they could be cut into wood in the guise of runes, all this makes

fascinating reading, but I have not the space to go into these entertaining details. Suffice it to say that to-day, with the help of our west-European alphabet, we can reproduce almost every sound of every language that is being spoken on our planet. The system is by no means perfect. Our alphabet might conveniently borrow a few letters from its Russian neighbor. But whatever the mouth speaketh, the hand can now preserve for all time.

Hence knowledge has become an imperishable commodity.

Hence we grow more and more learned every day.

Hence we may even hope that some day we shall also be wise.

. . . . . .

Written language, being at heart a form of painting, depended for its success very much upon those materials upon which it was taken down.

The Egyptians had scribbled their hieroglyphics all over the walls of their graves and temples. But the tally sheets of Corinthian raisins and Attic laurel leaves sold by a merchant from Tyre to a jobber in Carthage demanded some other and less bulky substance for their perpetuation—something that could be put into a man's traveling-bag and carried on board a ship or packed away on the back of a mule.

Once again necessity proved herself the mother of invention. The Chinese, always a little ahead of the rest of the world, were responsible for the discovery of paper. They were the first to notice that one could make a substance suitable for drawing and writing purposes out of the fibrous matter of a number of plants. In the thirtieth century before the birth of Christ, the Egyptians followed their example and began to fabricate a substitute for temple walls and coffin-covers out of the papyrus plant which then grew all over the delta of the Nile. But the Phœnicians, after their pleasant habit, grabbed that industry and the pap

(The Mouth)
THE PAPYRUS PLANT

rus-making business soon centered around the Phœnician town of Gebal which the Greeks pronounced "Byblos." The trade-name stuck. The town of Byblos has long since gone the way of most cities in the eastern Mediterranean, but the name of its chief article of export has survived and the holy books of the people of Europe are still named after the city which many centuries ago made the best sheets of papyrus, the best ropes and the best ship mats.

As for the paper which we ourselves use, the so-called rag-paper, that did not come to Europe until much later. It also was of Chinese origin and it reached the West by way of Samarkand, Arabia and Greece. From there it spread all over the world. It has steadily deteriorated during the last hundred years with the result that our modern books will probably last one tenth of the time of those printed two centuries ago.
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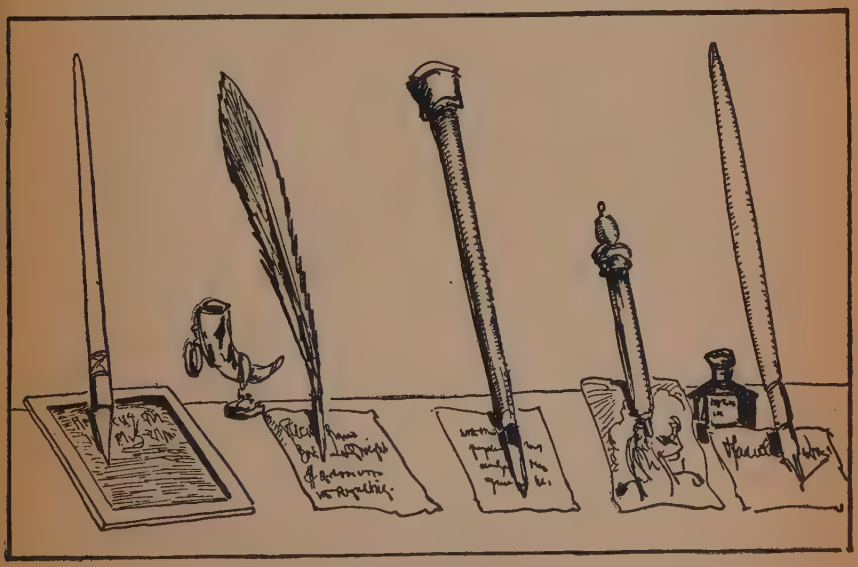
Paper, however, was not enough for the purpose of preserving ideas in a concrete form. One also needs something with which to write down the signs that represent the different sounds. The Romans in their daily lives had contented themselves with little wax slates and a sort of copper burin. When Cæsar invited you to dinner, he sent the maid with a little slate. But for official purposes they used the Egyptian papyrus and a sort of ink. This sort of ink had come from Egypt and closely resembled paint. The Chinese had done still better by inventing a mixture of gum and charcoal which made nice black letters. But our poor friends of the early Middle Ages (the period when the artificial multiplication of our natural powers was regarded with deep suspicion) were forced to muddle along as best they could with strange fluids made out of iron-gall and pigments secreted by the cuttlefish, until the great revival of intellectual curiosity

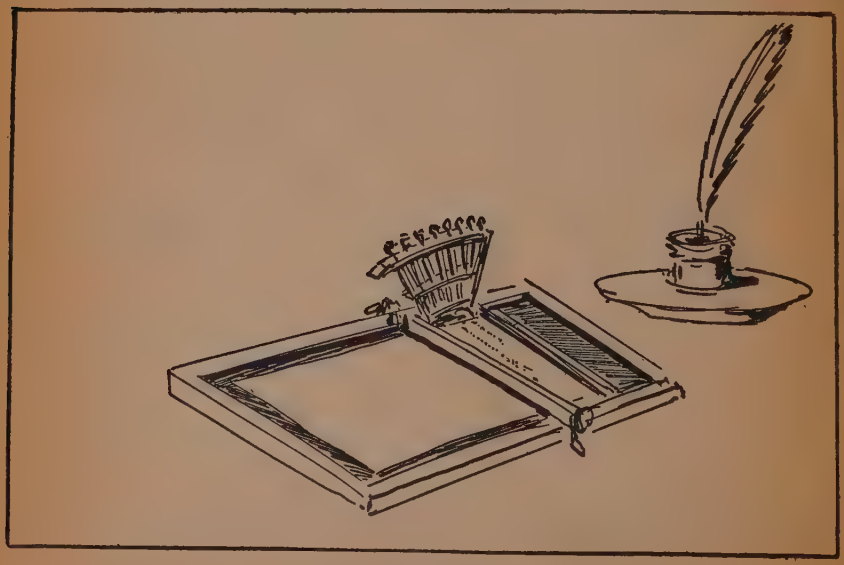


(The Mouth)

THE WRITING PENS

of the fifteenth century gave them not only a decent sort of ink but also the lead-pencil.

During those same years, writing ceased to be the prerogative of the learned and became one of the most popular of indoor-sports for all the world. Everybody began to have ideas and felt that they should be preserved for posterity. So fast and furiously did people then begin to write that even the useful fountain-pen made its appearance and people began to search seriously for a substitute for the all too perishable goose-quill. They did not succeed in this quest until the beginning of the nineteenth century. But by that time the writing craze had attacked all the world and even the fast scribbling pen was found to be too slow to keep track of all the million things people wanted to tell each other. It was the age when the machine was beginning to do the work of the human hand, and it was felt that the business of writing should also be entrusted to a convenient little engine to release the aching fingers from the degrading



(The Mouth)

THE TYPEWRITER

necessity of uninterrupted pen-pushing. The typewriter was the answer to this cry of agony on the part of the white-collar brigade. Where formerly they wrote ten pages, they could now tick thirty. And as many extra copies as they liked.

. . . . . .

A bad orchestra conductor can spoil a good composition in a variety of ways, but none of these is quite as fatal as the habit of placing the wrong accent upon the wrong note.

Historians are apt to make the same mistake. Not because they mean badly but because since time immemorial they have been in the habit of repeating each other and have rarely taken the trouble to submit the ancient scores to a new interpretation.

There is the matter of the invention of printing. It made a deep impression upon the people of the fifteenth century, for to them it seemed to have come as a Godsend. Just when they were most eager to buy cheap books, the obliging Mr. Gensfleisch (Gooseflesh) provided them with a method of multiplying written texts that brought books within the reach of almost every one. Ever since the faithful historians have been praising Herr Gutenberg as one of the greatest benefactors of mankind. He derived little enough profit from his strenuous labors.

But the art of printing belonged to a category which we might call the unavoidable inventions. It was one of those multiplications of our natural powers that were sure to make their appearance as soon as there should be a sufficient demand for them. Therefore the man who, long before anybody else thought of it, began to worry his brain with the perplexing puzzle how to preserve ideas as if they had been so many sardines is the hero who ought to have the statues and the glory. While the man who merely transferred the tedious business of copying from the human hand to the mechanical hand deserves honorable mention, but very little else.

Because we do not know the name of the former, we never mention him.

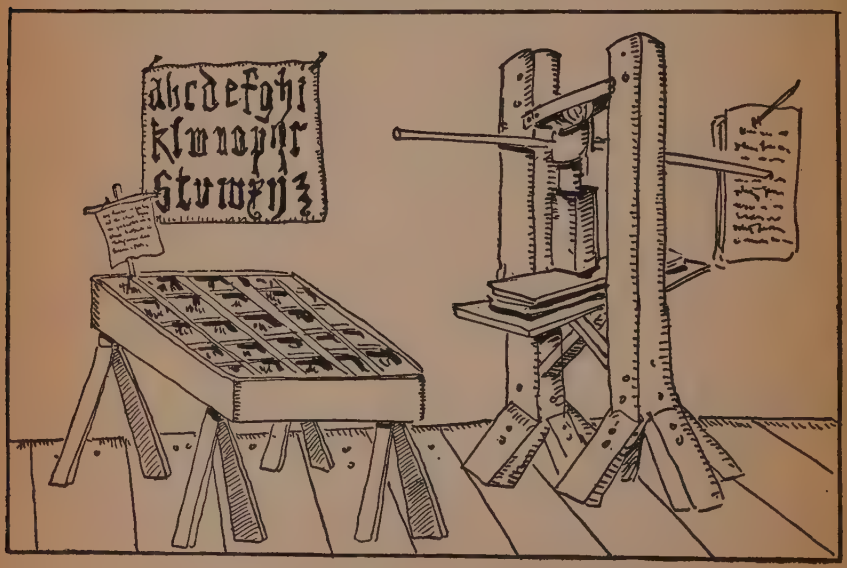
What difference does it make who he was or where he lived or died?

Can't we have a monument to the Unknown Scientist?

. . . . . .

Since this chapter is not being written in praise of either the Mainz jeweler or the Haarlem sexton (his most dangerous rival for the honors of having been the first to print books from movable type), I can state briefly that the act of printing was a great deal older than we usually think.

The Chinese were the first to print pictures from wooden blocks. But whether their invention ever came to Europe and when (if at all), we don't know. In the thirteenth and fourteenth centuries, however, pictures of saints were regularly struck off from little blocks of wood upon which they had been previously



(The Mouth)

THE PRINTING PRESS

engraved by some local artist who found that painting thousands of them by hand took too long.

With the increase of learning and the even more important revival of general business which took place during the fifteenth century, there was a demand not only for a rapid method of literary reproduction but especially for a cheap one. That is what Gutenberg and his fellow workers gave us, an inexpensive way of multiplying the written word. In proof whereof let me draw your attention to the first issue that came from his press. It was a business document, an Indulgence blank, a piece of paper arranged like an application for telephone service, something that was needed in hundreds of thousands of copies that would have cost a fortune if written by hand.

The printing-press has belied its origin. It is a sort of inky mouth, spewing forth information, instruction and entertainment, and like the human mouth it can utter words of wisdom and words of folly with equal ease.

It is one of those inventions that will probably never be entirely discarded, but it will be relieved of many of its services by the invention of that veritable artificial mouth known as the radio.

Radio is so new that we cannot possibly predict what it will be able to do for us or what it will do to us. But it has reinstated the human mouth in all its former glory. The mouth, being a free agent (like the hand and the foot), may choose to talk nonsense. But that is neither here nor there. The main thing is that after forty centuries of inventions we seem to have returned to the point from which we started.

In the beginning, man imparted his own knowledge to his neighbors by means of his vocal cords.

Then he tried to reach them by way of the printed word.

Now once more he talks.

But whereas formerly he could address only a handful of

(The Mouth)

THE NEWS-SHEET

fellow tribesmen, gathered around the village fire, he can now speak to millions—yes, theoretically at least, it is possible for him to speak unto every man, woman and child on this planet at one and the same moment.

No mean achievement, and one that gives us hope.

. . . . . .

Now that more and more people are "listening in" whenever anything of importance is happening, it is quite possible that another form of augmented mouth, the newspaper, may at some future date go out of existence altogether.

In the beginning the newspaper was exactly what the name implies. Bits of information which were too important to be entrusted to the town-crier were printed on a piece of paper and were fastened outside a shop-window where the crowd could read them and perhaps buy a pound of tobacco so as to be able to discuss the events with the storekeeper. As the price of dif-

ferent commodities began to depend more and more upon political developments in different parts of the world, certain enterprising gazetteers maintained regular correspondents in the main centers of commerce and two or three times each week they collected whatsoever seemed to be of importance and sent it to their employers, who with the help of a small case of movable type, a pint of printer's ink and a press, shouted the information from the house tops by sending their "courant" to a few thousand of the more solvent members of society.

The few thousands have now grown into a few millions. But as there are never enough important events within a single day to fill sixty or seventy enormous pages with honest-to-goodness "news" the rest of the space is taken up by various attempts to entertain the same crowd which in the old and illiterate days derived its chief amusement from a public hanging or the drowning of a witch.

. . . . . .

(The Mouth)

THE NEWSPAPER

The present chapter is getting to be rather long but ere I finish I must speak of another invention connected with our eagerness to store up information in a permanent form.

A picture, as I have told you before, is merely a story told by means of lines and a few patches of color. When I dive to the bottom of the ocean and run across a new sort of fish, I can either tell the rest of the world of my discovery by making certain sounds, the meaning of which has become clear to my hearers through long practice, or tell them by converting those sounds into small black and white symbols, neatly noted down upon a sheet of paper, which are understandable to all those who have been taught the meaning of those pictures, and finally I can take a pencil or a brush and draw a likeness of the prickly monster in such a way as to make others feel the exact impression the creature made upon me.

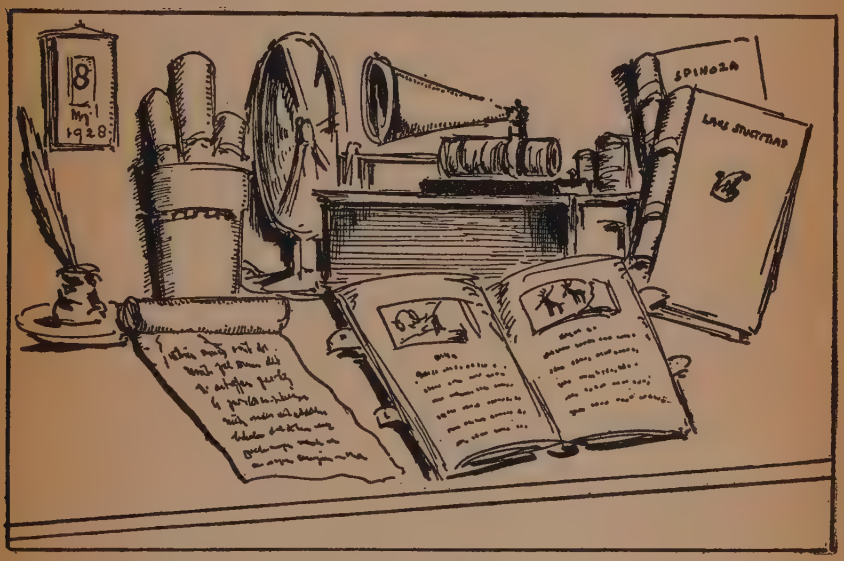
People knew that this could be done even before they found out that information could be retransmitted to the ear as well as to the eye.

As a matter of fact, most children (and children are merely a species of savage until they are exposed to a little education) go through the story-drawing period several years before they reach the point where they can express anything in reading and writing. All mankind, in the days of its youth, resembled one vast nursery, the walls of which were covered with pictures.

The ancient world recognized the value of pictorial information to the fullest extent. The Greeks and Romans taught the art of reading and writing only to those who were supposed to have need of it, and who might be expected to use their knowledge in an intelligent fashion. To force a peasant, who would never in his life either send or receive a letter, to spend five years of his childhood in a stuffy schoolroom that he might be able to spell his own name, would have struck those hard-headed rationalists as utter folly. They would just as lief have tried to

explain the principles of musical composition to a deaf mute.

The Middle Ages thought likewise and those who could not be reached by word of mouth were told whatever they had to know by means of pictorial representations. But as the number of people who were to be taught increased and there was a greater and greater demand for stories about the lives of the saints and the valorous deeds of the ancestors, efforts were made to speed



(The Mouth)

KEEPING RECORDS OF THE SPOKEN WORD

up the output of holy images by means of mechanical appliances. This led, as I have said before, to the discovery of block printing —a method by which two or three thousand pictures could be struck off from a single piece of wood.

But while this method would do very well as long as it remained confined to imaginary representations of more or less imaginary events, it was not quite as satisfactory when applied to scientific problems. No one could object to a wood-cut of the tower of Babel, as the guess of one artist about that legendary

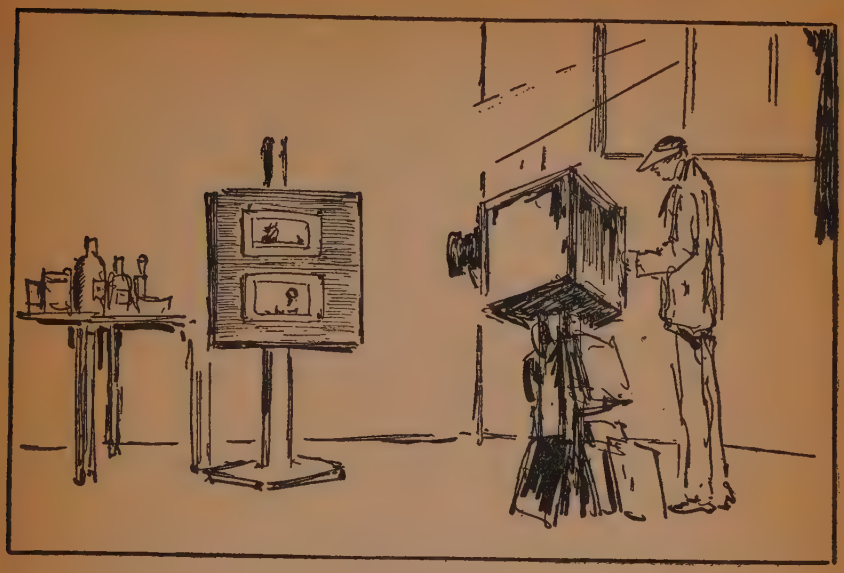
edifice was apt to be as good as that of the next. But a jelly-fish in a bottle or the muscle of an arm had to be rendered exactly as they were or they would have been of no earthly use to students of Ctenophora and anatomy.

This led to a variety of experiments, all of which endeavored to relate animate and inanimate objects in a permanent pictorial fashion with greater precision than they could ever be described by telling about them either in print or by the living voice.

For a long time these experiments were brilliantly unsuccessful. With the help of mirrors and lenses and dark rooms one could temporarily catch a landscape upon a piece of glass, but between "catching" and "keeping" that selfsame landscape there was after all a very painful difference and the moment the light was gone, the picture was lost.

But a little over a century ago, luck decided to take a hand in the game and show us poor patient mortals a way out of the difficulty. Two Frenchmen, Louis Daguerre and Nicéphore Niepce (the latter a universal genius who came within an ace of giving us a motor), had been working for quite a long time with a variety of chemical solutions, several of which made it possible for them to "catch" images on plates of glass but none of which seemed able to "preserve" these pictures once they had been taken. One day by the merest of chances, Daguerre left a few of his sensitive plates, which had already been exposed to the sunlight, in a cupboard in which there stood a bottle of mercury. To his surprise he found that something had happened to these plates which had never happened before. That was the beginning of a marvelous piece of chemical sleuthing which ended with the invention of the art of photography, "the art of drawing by means of light."

From that moment on we were able to add precise graphic descriptions to stories that thus far had depended for their ac-



(The Mouth)
PHOTOGRAPHY

curacy upon the none too reliable testimony of the spoken or written word.

The new art spread far and wide. It was acclaimed everywhere as a great step forward. The chemical industry which just then was graduating with high honors out of the laboratories of the ancient alchemists, came nobly to the assistance of the "light writers."

Others invented machinery which could catch the subject that was to be "described" sitting still, running a race, being shot out of a cannon, or what-have-you. They perfected their moving picture cameras until they could tell pictures in "pictures" faster and better than any one could hope to tell them by means of mere "words," whether spoken or printed.

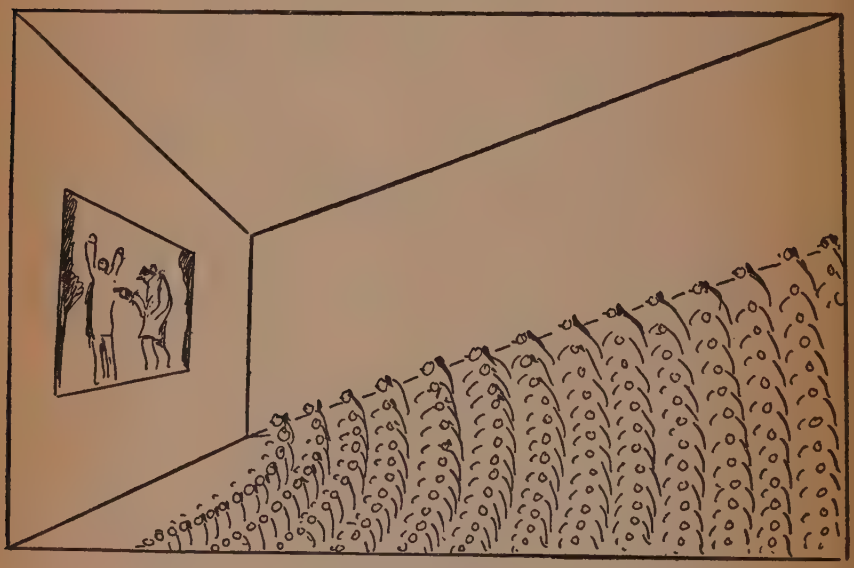
When Edison, after endless experiments with mechanical contrivances that should catch and return the human voice, finally gave us his "phonograph" or "sound writer," it was pos-

sible to combine "story telling" with "picture telling" in such a way that henceforth everything anybody ever said or did could be preserved in permanent form for an unlimited number of years.

We still have to learn a great many things and the scientific millennium is not exactly at hand.

But the human mouth, if I may mix my metaphors, can rest on its laurels.

It has multiplied its powers in such a way and so cleverly that for the purposes of information and misinformation, the human race to-day is one.



(The Mouth)

THE MOVING PICTURE

CHAPTER VI

The Nose

THIS chapter will be short. The nose is the origin of the sense of smell and the sense of smell is something which seems to allow of no augmentation or intensifiation. The moment this book is printed, I shall probably remember a few dozen inventions that have to do with man's desire to multiply the powers of his nose, but just now I can't for the life of me think of a single one. And I am somewhat puzzled by the apparent neglect of such a tremendously useful organ. Perhaps the reason is to be found in the fact that the sense of smell is one of those heritages of our biological past which have been less impaired by the weakening process of civilization than any of the others.

I have a suspicion that even to-day our nose is a much more faithful and reliable guide in our daily intercourse with our neighbors than we should ever be willing to confess. To most people there is something indelicate about the nose. It makes them think of colds and painfully reminds them of their close affinity with those lower animals which "smell" their way through life in a visible (often an all-too-visible) fashion. The average person would angrily resent the implication that his nose had anything at all to do with his public conduct. Quite as much as he would recoil from being told "right out in meeting" that he was a mammal. I might as well let it go at that. A thousand years from now we may be bright enough to pay some attention to our olfactory potentialities.

To-day we are not, and in the museum devoted to the achievements of Multiplex Man the nose is not to be found. The poor proboscis stands sniffling outside, the Cinderella among the organs, doing a thousand odd jobs and getting no other recognition than an occasional flick of a perfumed handkerchief.

CHAPTER VII

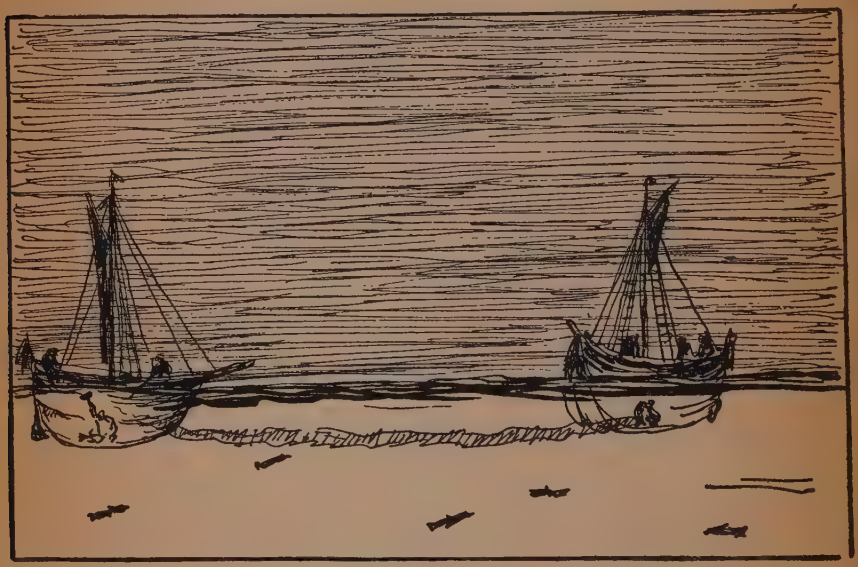
The Ear

THE ear, too, has not done so well from the point of view of artificial multiplication. But it has a more interesting record than the nose, for there are quite a number of inventions which have no other purpose than the unlimited reënforcement of the power of hearing. Most of these are of very recent origin and consist of artificially constructed ears which are able to catch the noise made by an aeroplane propeller long before their human counterpart has noticed anything out of the usual. No doubt the development of aircraft will force us to pay more and more attention to the art of long-distance listening. But until a dozen or so years ago, we were trying to listen intensively rather than extensively and the few original inventions connected with the ear all show their common origin and purpose.

It would of course be possible to argue that the telephone and radio should be classified under this chapter heading. A good case could also be made out for the loud-speaker as an amplified ear. But I believe that properly speaking all these instruments belong to the mouth. Their main purpose is to "tell" something at a distance. The speaking end, therefore (the mouth), is enormously magnified while the ear as the organ of

hearing is left practically as it was before. Until I am definitely shown that I am wrong I shall therefore leave them where they are, and here I shall mention only such inventions as are a direct outcome of our necessity to hear-with-greater-precision.

Water being an excellent conductor of sound, it was quite natural that the value of the multiplied ear should have first been realized by the men of the sea. Already the Norsemen seem



(The Ear)

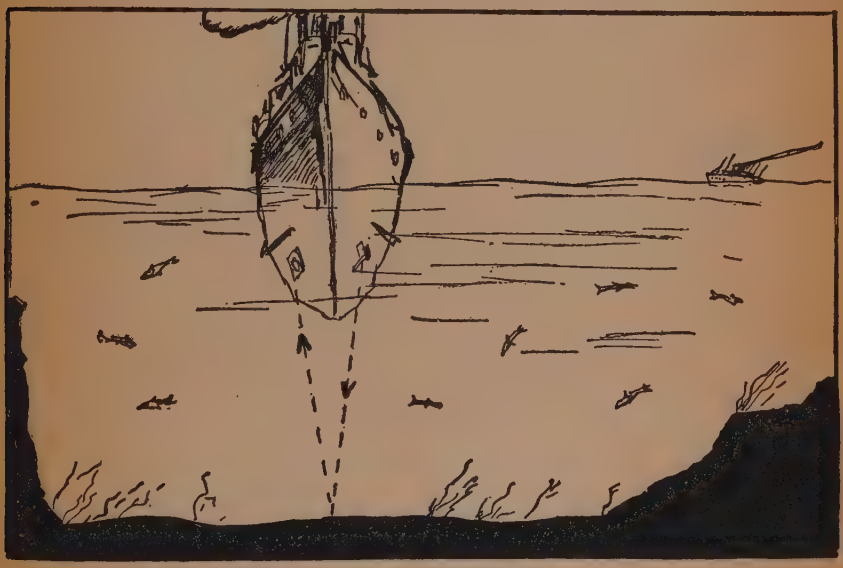
UNDERWATER SIGNALS IN ANCIENT DAYS

to have known that when one hit the walls of a wooden ship below the water-line, the sound could be heard quite a distance away by those who had their ears glued to the side of their own vessel at some spot a few feet below the level of the sea. Even to-day in certain parts of the northern Atlantic in case of fog, sailing ships that have been becalmed and wish to remain close together communicate with each other by means of tapping the sides of their vessels.

This method, however, would be a little too primitive for large

ocean steamers and they have increased their power of hearing with different electrical devices which perform a number of tasks formerly entrusted to the hand or to the eye, such as finding out how deep the water is or whether there are any hidden rocks or whether the vessel is approaching land.

On shore there is no need of such instruments. Even if there were it is doubtful whether they could be used amidst the con-



(The Ear)

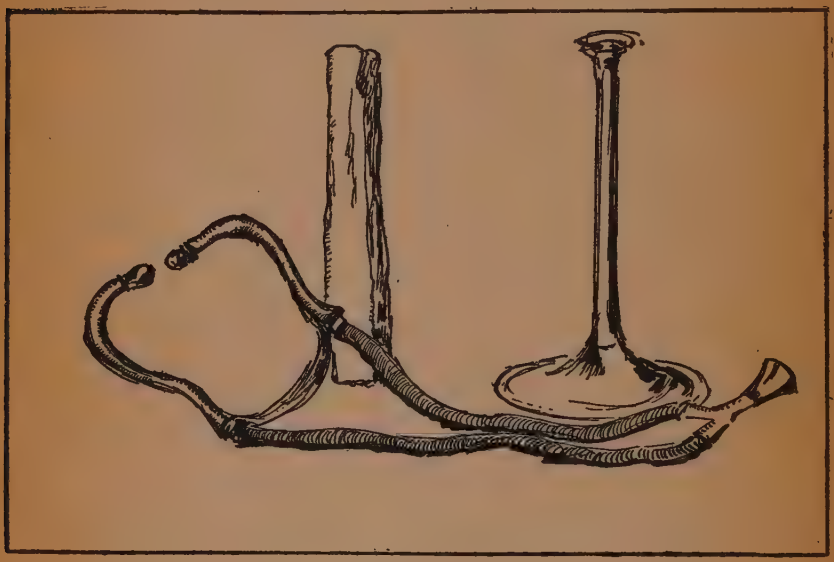
THE MODERN UNDERWATER SIGNAL

flicting noises of our modern cities. But in the quiet of his room, the physician, reënforcing his ear with a stethoscope, is now able to listen to a number of things that formerly were completely out of reach of both his eyes and his hands and along that line we may probably look for further developments of great value.

There may be other instruments that are merely multiplications of the power of hearing. But I do not know what they are.

But I hope that they won't mention the dictaphone, for somehow or other that useful implement of high-class sleuthing does

not seem to fit into this book. I know that it exists and plays a great rôle in the lives of all movie detectives, giving them an opportunity to frustrate plots and expose counterfeiters. But somehow or other it does not seem to belong in a book that is chiefly devoted to a chronicle of human progress.



(The Ear)

THE STETHOSCOPE

CHAPTER VIII

The Eye

We spend our lives on the bottom of a vast ocean of air which is so deep that no one has ever been able to reach the surface. During certain hours of every day the whole of this vast air-sea is exposed to the rays of the sun. When that happens we say that it is light and that we can see. For we happen to belong to a species of living beings which is provided with a sense of vision and in the front of our head we carry two curiously shaped instruments which allow us to "see." What exactly this business of "seeing" is, I do not know. And for the moment it interests me no more than the fact that the color red is produced by 392,000,000,000 impulses per second on the retina while violet demands double that amount, or 757,000,000,000 impulses per second.

Nor do I want to discuss the allegation of certain famous physicians that the human eye is one of the most awkward of nature's many clumsy devices and that almost any first-rate manufacturer of optical instruments would have been able to give us something infinitely better and more serviceable.

Such little bits of scientific gossip are interesting (if true), but they lie outside of the realm of the present volume and shall receive no further attention.

Behold, therefore, our earliest ancestor gazing into space and in a vague and none-too-certain way wondering what it is all about.

He knew, of course, what his eyes were for. They allowed him to observe those objects that were within a comparatively short distance of his eyes.

He must have realized that the "power of observation and discernment" was located in the two round balls situated on both sides of the opening by means of which he was able to smell the track of wild animals, and right above the slit through which he could fill himself with food and which enabled him to utter those cries of warning which in times of danger allowed him to communicate his own fears to his friends.

What this power of observation was, he probably knew no better than we do, half a million years later. But that it must be situated in those two round balls in the front of the head was certain, since the closing of the eyelids made a temporary end to all "seeing" and since those whose faces had been clawed by a tiger or a bear were so completely helpless that they had to be killed lest they make a nuisance of themselves and endanger the safety of the rest of the tribe.

One other thing must have penetrated to his consciousness: those two little round balls right above his mouth and his nose lost all usefulness the moment the sun had disappeared beyond the distant horizon.

It seemed that certain other animals were able to see even when it was dark, but the species to which man belonged did not enjoy that advantage. Hence when the day came to an end, human beings were forced to retire to their nests or their caves or wherever they happened to sleep and there await the first rays of the next morning.

As soon, however, as it had been discovered that one could not only keep a fire going that had been taken from a burning bush,

but also that one could make fire by artificial means, the night lost a good many of its terrors. Thereafter the human eye was able to fortify itself with a substitute for the light of day in the form of a torch. But the torch was not an ideal instrument of illumination. It was a very important invention, but it was only a beginning. One after another, all the different materials that were in the least inflammable were used for purposes of

(The Eye)

THE CAVE-MAN'S TORCH

illumination, but very little progress was made until it was discovered that one could put some fibrous material in a bowl of oil or grease and keep it burning as long as the oil or the grease lasted.

In that way the "lampas" or "torch" of the Greeks became the lamp of the modern world.

The heroes of Homer still feasted by the flickering flames of torches. But four hundred years later the temples of the gods were made resplendent with the soft radiance of innumer-

(The Eye)
THE OIL LAMP

able small oil lamps and a century afterwards the oil lamp had become an integral part of every well-appointed household and far underneath the ground, miserable slaves, chained to the side of the mine walls, were hacking away at the coal and copper by the uncertain light of portable lamps made out of lead or iron.

For almost a thousand years smoky and smelly oil lamps were all we had for purposes of illumination. Then the lamp began to change its shape and slowly grew into the candle, which is really a lamp in which the oil has been discarded for tallow, but in which the wick has been retained as before.

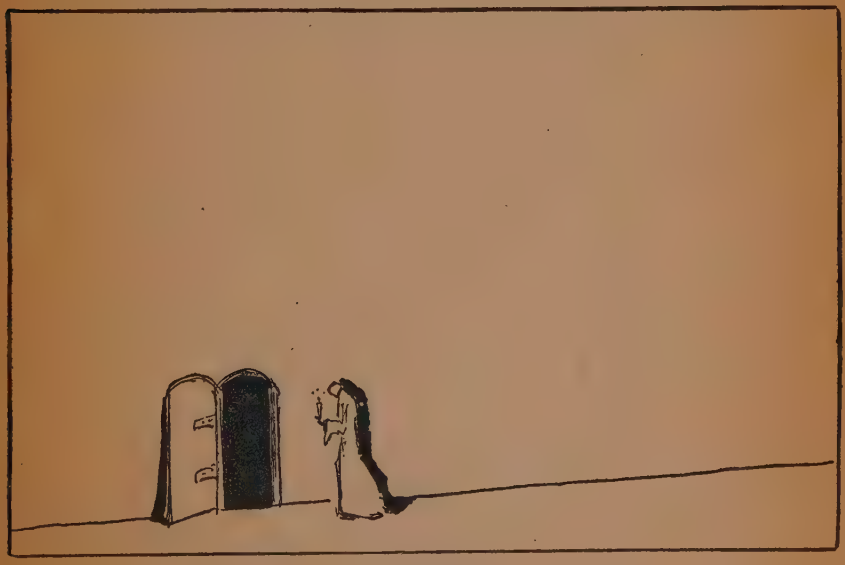
During the twelfth century the artificial "glowers" found their way across the Alps and by the middle of the thirteenth century they had come into general use. And thereafter they maintained themselves as the exclusive auxiliaries for the eye-in-the-dark for several hundred years.

During this time many experiments were made with substitutes for the traditional tallow, but the only material that

would serve the purpose was beeswax, and as beeswax was very expensive, these candles were never found outside of churches and palaces.

Even there they could dispel only a few square yards of darkness, and when the living conditions of the masses began to improve and more and more people desired to keep awake a few hours after their horses and cows, there arose a demand for a better way of fighting the discomforts of night.

The problem was finally solved by tapping that same reservoir of prehistoric energy which just then was beginning to set the wheels of a million engines going, but in a somewhat different fashion. The existence of certain invisible substances which had neither volume nor shape was perfectly well known to the Greek physicists who lived twenty-five centuries ago. But they regarded them with grave suspicion, as mysterious forces capable



(The Eye)

THE CANDLE

of great harm and small good and did not inquire whether they could be used for any practical purposes.

To the alchemists of the Middle Ages, this pneuma or aura or spiritus or whatever they liked to call it came as a veritable blessing. The queer flames they produced were of great assistance in wheedling money out of recalcitrant customers and one old sinner specialized so successfully in the manufacture of "emanations" that quite by accident he happened upon the substance which nowadays we know as carbon dioxide, but which impressed him so deeply that he favored it with a new and imposing name, derived from no lesser source than the Greek word "chaos" and called it "gas."

The name stuck, although van Helmont himself has long since been forgotten. To-day, however, when we say "gas" we usually mean the particular gas which is distilled from coal and is used for illuminating purposes. The burning propensities of coal-gas had been noticed as long ago as the seventeenth century. But the man who was responsible for that invention was ahead of his time. Pigs' bladders filled with gas and used for trick lighting stunts remained part of the side-shows of country fairs, but the average man continued to be dreadfully afraid of the dangerous effluvium which was supposed to pour out of a crack of Hades and would not have it in his house, lest he be suffocated in his own bed.

During the wars of the French Revolution, when balloons suddenly gained great military virtue, a Belgian physicist tried the experiment of filling the large paper bags with gas instead of hot air, and having manufactured more of the stuff than he needed for aeronautical purposes, he used the surplus to light up his own apartment. People looked at this effort to turn the night into day with distinct disapproval and it was not until well after the Napoleonic wars that coal-gas began to be used in a general way for the purpose of illuminating houses and public thorough-

fares. Even then thousands of people were bitterly opposed to this innovation and they found cordial supporters among the ecclesiastical authorities.

These worthy divines offered a variety of reasons for their disapprobation of the new lighting system. As a rule they based their interdicts upon that chapter in Genesis which explains how God made both the day and the night. From this they concluded that all efforts to improve upon God's handiwork by giving the eye a chance to see with perfect clarity after sundown were blasphemous expressions of human arrogance.

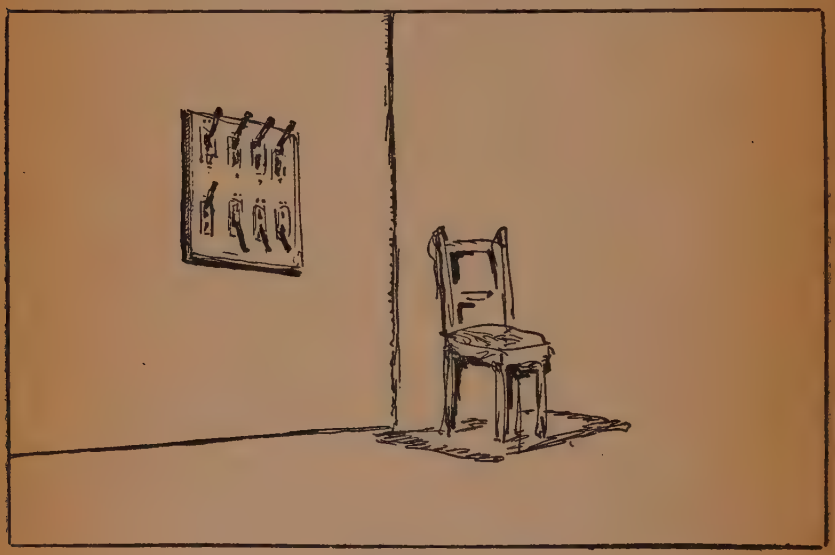
But the most brilliant excuse for keeping the lamplighter off his streets was given by the ruler of the good city of Cologne, who declared that the use of gas was not only unchristian but also unpatriotic. For people, so he reasoned, who lived in gas-lit towns would no longer be impressed by festive illuminations, and festive illuminations were an everlasting source of inspiration

(The Eye)

THE LAMP LIGHTER

for an exalted form of patriotism and respect for the reigning dynasty.

To-day all this sounds quite absurd. Gas as a substitute for the light of day has been adopted by all the world. It reigned supreme until some one invented a way of changing coal into electric energy. Since then a single citizen, bright enough to throw a couple of switches, can light up an entire city.



(The Eye)

THE ELECTRIC SWITCH

At last the human eye had been set free from the curse of darkness. And people did what they will always do when they are suddenly given a great deal of liberty. They began to abuse their new freedom in a scandalous fashion. Eyes that had been given them that they might be used for seven or eight hours of the day were forced to read all through the night. The poor things could not stand the strain and soon began to show signs of wear and tear. It was necessary to reënforce them for those who were obliged to read or write for the greater part of every

twenty-four hours. The difficulty was solved by the introduction of "spectacles" or "glasses."

Roger Bacon is usually named as their inventor. He may have been or not. We don't know. Bacon was one of the few independent minds of the thirteenth century, and as such got blamed for almost everything new that appeared above the horizon between the years 1214 and 1294. And anyway for a

(The Eye)
THE SPECTACLES

long time glasses were of very little practical use, as they were regarded primarily as a luxury and not as a necessity and therefore were a hindrance quite as often as a help. Yet thousands of people used them. For there is in every one of us a streak of vanity. During a period when ninety-five per cent of all the people could neither read nor write, it was quite a swanky thing to embellish one's nose with glasses. They proclaimed to the poor devils who were too poor to buy them: "Behold! I have spent so much time upon my studies that my eyesight has suffered from too close application to learning."

This widespread snobbishness caused an equally widespread prejudice against glasses and it lasted until very recently. The substitute eyes made out of polished crystal were derided as an affectation unworthy of real men. As Heinrich Heine discovered when he called upon the oracle of Weimar and was told that he could not appear within the presence of the great and glorious Goethe without first removing his specs.

. . . . . .

And now to more serious business, for we have not yet mentioned the very important efforts that have been made by man to multiply his power of vision in such a way that he should be able to cast his glance into the most hidden and inaccessible secrets of nature.

Electricity gave him opportunity to devise a long-distance eye called a searchlight, which permitted him to examine the sea or the air during the night as well as during the day. But search-

(The Eye)

THE SEARCHLIGHT

lights are too intimately connected with warfare to be of any special use in time of peace. There are two other varieties of the multiplied eye which are of much greater usefulness.

There were the heavens. Man, a humble prisoner on a small planet, has always been profoundly curious about the objects that surrounded his own domicile.

But in the beginning the eyes were all he had with which to study the stars. To judge by their achievements as astronomers, the Babylonians and the Egyptians and the Greeks seem either to have enjoyed excellent eyesight, or to have been possessed of a highly developed sense of observation. What they saw, they saw correctly, but their range of vision was necessarily limited. For they were obliged to rely upon the human eye unassisted by any of those artificial multiplications of the power of vision which are to-day at our disposal.

(The Eye)

THE GREEK ASTRONOMER

The learned Roger Bacon not only seems to have discovered our spectacles; he also described a method by which one could construct a "far-seer" or telescope. Whether he ever made such an instrument for his own amusement is uncertain. He was a busy man, and during the many years he was not allowed to put pen to paper he was as a rule much too poor to indulge in expensive optical experiments.

Anyway, nothing was done about the telescope until four hundred years after his death. Then the fury of the Reformation had at last spent itself and for a short while people could indulge their desire for scientific speculations. At the same time little ships were beginning to sail across every inlet and bay of

(The Eye)
THE TELESCOPE

(The Eye)

THE ASTRONOMICAL OBSERVATORY

the Seven Seas and their mariners were in great need of an instrument that should allow them to see-at-a-distance. Small wonder, therefore, that the telescope was invented by inhabitants of the Low Countries, where navigation had been elevated to the rank of a fine art.

From Holland telescopes were exported to every part of Europe. One of them fell into the hands of Galileo and the purpose for which he used it justified the decree of the general of the Franciscans when he had forbidden Roger Bacon to continue his dangerous studies in the realm of applied physics. For Galileo, with a far-seer of his own fabrication (a childish enough instrument when we compare it to one of our modern telescopes), enlarged the dome of heaven by so many thousands of miles that all the old notions about the importance of the Earth and its sister-planets and its fiery little Sun were completely upset, and that the whole of the universe came in for a thorough house-cleaning.

Rather than revise the comfortable opinion which they had held since the year one, the majority of the people preferred to call Galileo and his fellow astronomers dangerous radicals and perfidious fellows who should be prevented from teaching their outrageous doctrines to the younger generation.

In the end, as always, man's divine curiosity triumphed. He continued to increase his range of vision until to-day with the help of gigantic telescopes he is at last beginning to get a faint idea, not of where he is but at least of whither he is going.

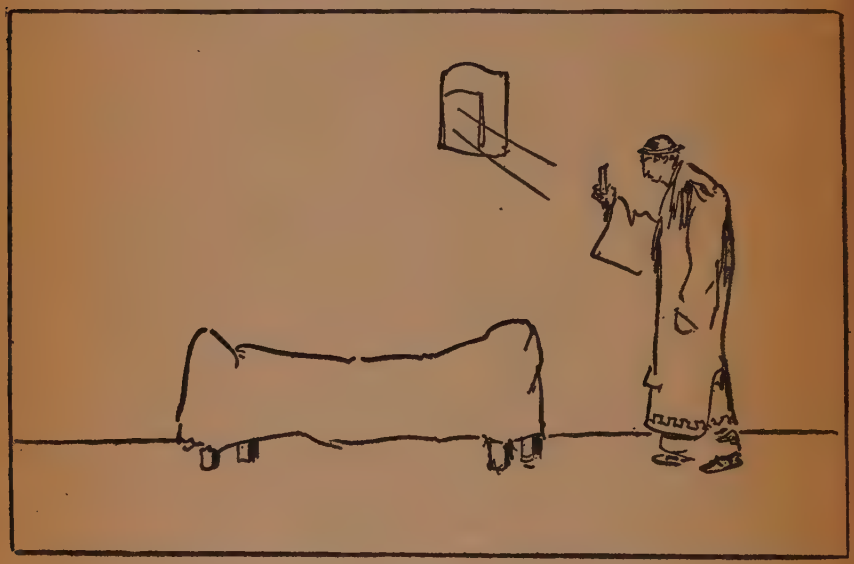
. . . . . .

Now while certain people were devoting themselves to the problem of seeing extensively, others were trying to discover a way of seeing intensively. For as soon as it had become clear that there was a world which existed outside of our range of observation, because it was situated so far away that it could not possibly be sensed by the naked eye, it was suspected that

there might also be a world composed of creatures so infinitely small that they could not possibly be noticed without the assistance of a differently multiplied power of vision.

The Greeks were the first to have suspicions in this general direction. Without lenses of the proper sort, those suspicions could not be revaluated into actual knowledge.

The most the ancients could do to magnify the human eye was to look at an object through a hollow sphere filled with water, and that was little enough.



(The Eye)

THE INVISIBLE MICROBE

But once lenses had been invented, people were on the right track. Four hundred years were spent in making experiments and then, during the first half of the seventeenth century, some one in Holland by the name of van Leeuwenhoek combined a few lenses in such a way that at last the human eye was able to detect the little organisms whose existence had been predicted thousands of years before.

The new instrument was aptly called a microscope or a "small-seer." The first microscopes were painfully primitive but they were rapidly improved, and half a century ago we at last made the acquaintance of some of our worst enemies—the microbes. Not all of them, for even after the introduction of the most powerful microscopes, several of the nefarious tribe have managed to keep themselves hidden from our gaze.

In a world in which we have learned to look "through" people with the help of Professor Roentgen's extraordinary inven-

(The Eye)
THE MAGNIFYING GLASS

tion, almost anything seems possible and most of the problems of existence become reduced to two simple words: "Courage!" and "Patience."

. . . . . .

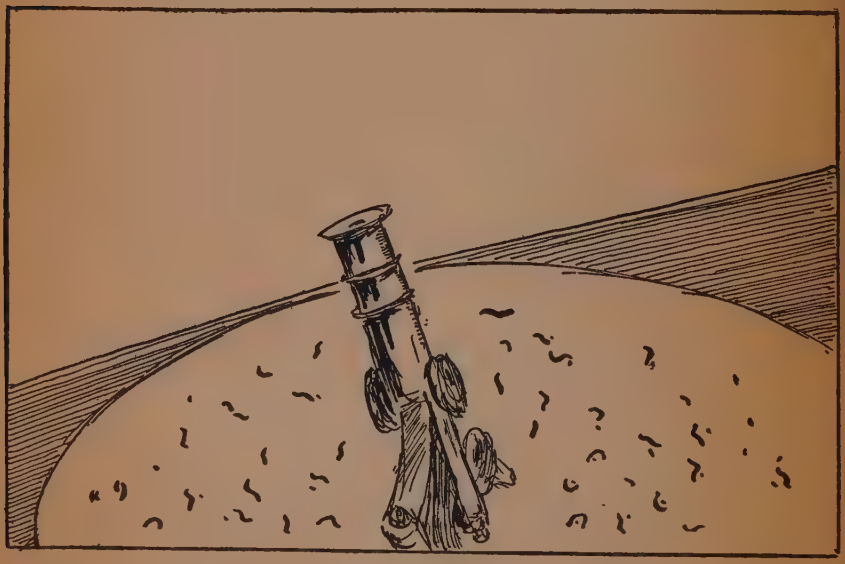
And that is all for the moment.

For my pictures have come to an end, and as Alice said quite rightly: "What is the use of a book without pictures?"

If I had had time and if printing were not so terribly expensive, it would have been easy to multiply my examples of the multiplication of the human organs until this book should have contained three thousand pages instead of less than three hundred. For I have merely touched upon a few of the high spots. The details have not even been mentioned.

Even now, the reader, if he has had sufficient courage to peruse this volume to the end, has probably said to himself: "Why did the ignorant fellow forget this? Why did he omit that? Why didn't he mention the stairs as an extension of the foot when he was discussing the road? Isn't a gimlet a multiplication of the powers of the hand? What about armor as an extra layer of skin? What about bloodhounds as a substitute for the human nose?"

And he would be right. Hundreds of other subjects could have been mentioned but this book does not pretend to be a



(The Eye)

THE MICROSCOPE

"History of Invention" or a collection of essays upon the unhappy lives of most of the pioneers of human intelligence.

On the contrary, it is merely an intellectual eye-opener.

Its purpose is to give the average reader a new point of view and to provide him with a short and workable outline which will enable him to do his own classifying hereafter by himself and get some amusement (and perhaps instruction) out of the perfectly harmless sport of dividing and subdividing all existing inventions.

But there is something else I have tried to do.

As I said in my foreword, the present book is really a confession of faith. The hammers and saws and balloons and telescopes were merely an excuse for saying a few things which are apt to be overlooked in this age of pessimism and spiritual despondency.

The underlying philosophy of the present volume is one of hope and optimism.

It shows us Man, not as a victim of fate, but as a creature endowed with practically unlimited powers for the development of his brain. It shows us Man still at the beginning of his career as a reasonable being, but rapidly discovering by which road he may eventually hope to escape from those difficulties which make his present existence such a torture.

I know that people will object and will say that salvation must eventually come through the spirit. Quite true! But the spirit has a poor time of it when the body has got to dig for potatoes in order to keep alive.

. . . . . .

Thus far Man has wasted too much of his time digging potatoes.

I want him to stop digging that he may have leisure to develop his higher faculties.

What use he will make of those higher faculties, we, who belong to the late Stone Age, are not able to prophesy, but the evidence of the past encourages us to expect that he will do better and better as he relieves himself more and more from that drudgery which so often has threatened to degrade him to the order of the bees and ants.

The present moment is in many respects an unfortunate one. Just now we are neither slave nor master. We multiplied the powers of our hands and our feet and our eyes and our ears that we might achieve liberty and suddenly we found ourselves at the mercy of those inanimate beings who had been created to serve us.

That, however, does not mean that we should never have tried to multiply our faculties.

It merely shows that we have not yet multiplied them enough.

That is the task which awaits us.